HIG-67-24

T-PHASE SOURCES AND EARTHQUAKE EPICENTERS IN THE PACIFIC BASIN

By

FREDERICK K. DUENNEBIER and ROCKNE H. JOHNSON

DECEMBER 1967

Prepared for

ADVANCED RESEARCH PROJECTS AGENCY
UNDER CONTRACT NO. Nonr-3748(01)
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HAWAII INSTITUTE OF GEOPHYSICS
UNIVERSITY OF HAWAII

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Date: 28 November 1967

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CONTENTS

ABSTRACT

Two years of T-phase source locations are compiled together with U. S. Coast and Geodetic Survey earthquake epicenters in the Pacific Basin for the same time period. It is shown that the T-phase sources have a higher density in regions which insonify the hydrophone array and an accuracy equivalent to or better than C&GS epicenters in regions where geometry is favorable, or where abyssal T phases are generated.

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INTRODUCTION

From December 1964 through January 16, 1967, T-phase sources in the Pacific Basin were located by the program described by Johnson (1966). Over this period, more than 20,000 events were located with enough precision to warrant publication. In the same period of time, the U. S. Coast and Geodetic Survey reported fewer than 10,000 earthquake epicenters in the Pacific area. It has been found that observation of the T phase significantly improves earthquake detection capability in the Pacific area. This report presents a compilation of two years of T-phase source locations and earthquake epicenters.

COVERAGE

The factors determining the regions covered by a hydrophone array are its limited geographical extent and the shadowing by land masses. T-phase records were collected from 20 hydrophones at seven stations in the North Pacific stretching from Eniwetok atoll to California. The North Pacific is reasonably well covered, but coverage in the South Pacific is restricted by shadows cast by mid-Pacific island chains. Shadowing results from a lack of noticeable diffraction of underwater sound around the land masses. For point sources, such as underwater explosions, distinct shadows are cast; whereas, shadowing is less distinct for earthquake T phases, which radiate from areas which may be many kilometers in extent. An example of a region where the reception of T-phase signals is severely curtailed by shadowing is the Fiji-Tonga region (Fig. 1). Deep earthquakes (depth > 200 km) and earthquakes occurring inland seldom generate detectable T phases, probably because of the attenuation of higher frequencies in the ground path as well as attenuation by spreading. Conditions conducive to the detection of a T phase are a short ground path and an unbroken sofar path to the hydrophone. In general, the signal must be detected by at least four well-spaced hydrophones for a source location to be computed.

ACCURACY

Accuracy of the T-phase source location is affected by accuracy of arrival-time estimates, geometry of the hydrophone network with respect to the source, and knowledge of the sofar velocity. The arrival time of the T phase is taken as the point of peak power, which should correspond to the arrival time of waves traveling at the sofar axis velocity. This time can be estimated within two seconds for some events, but for many others the uncertainty is much larger. An error of 10 seconds in reading the arrival time will cause an error of only 15 km in the travel-path length, as the sofar axis velocity is approximately 1.5 km per second. However, in areas where geometry is poor, the azimuthal spread of recording stations is the controlling factor and the computed source location may be in error by several degrees.

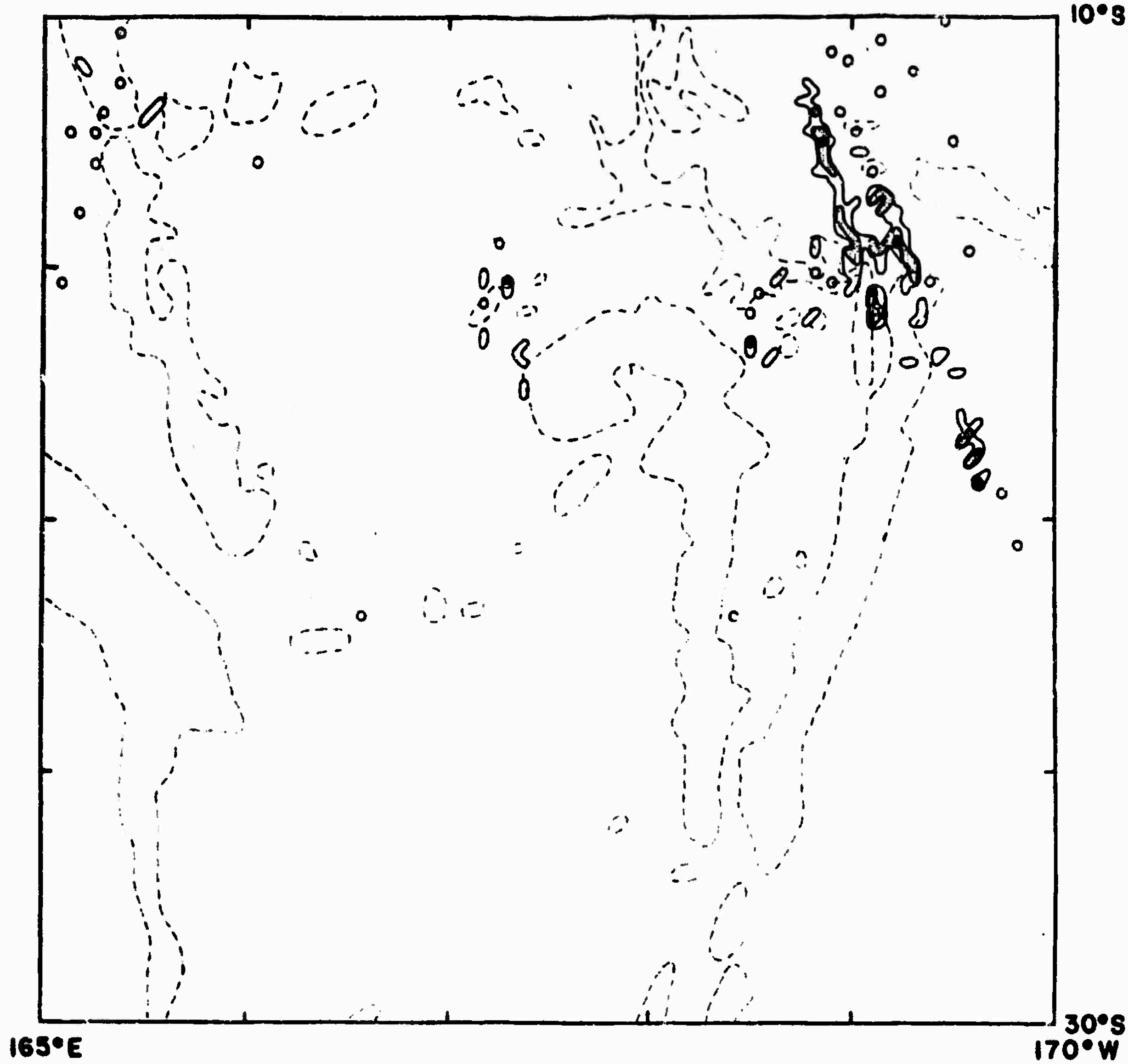

Fig. 1a. T-phase sources in the Fiji-Tonga region. Dotted line is the 1000-fathom contour.

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Key to Figures 1, 2, 3, and 6:

Number of sources per 0.2 square degrees

2-3 4-7 8-15 16-31 32-63 64-127

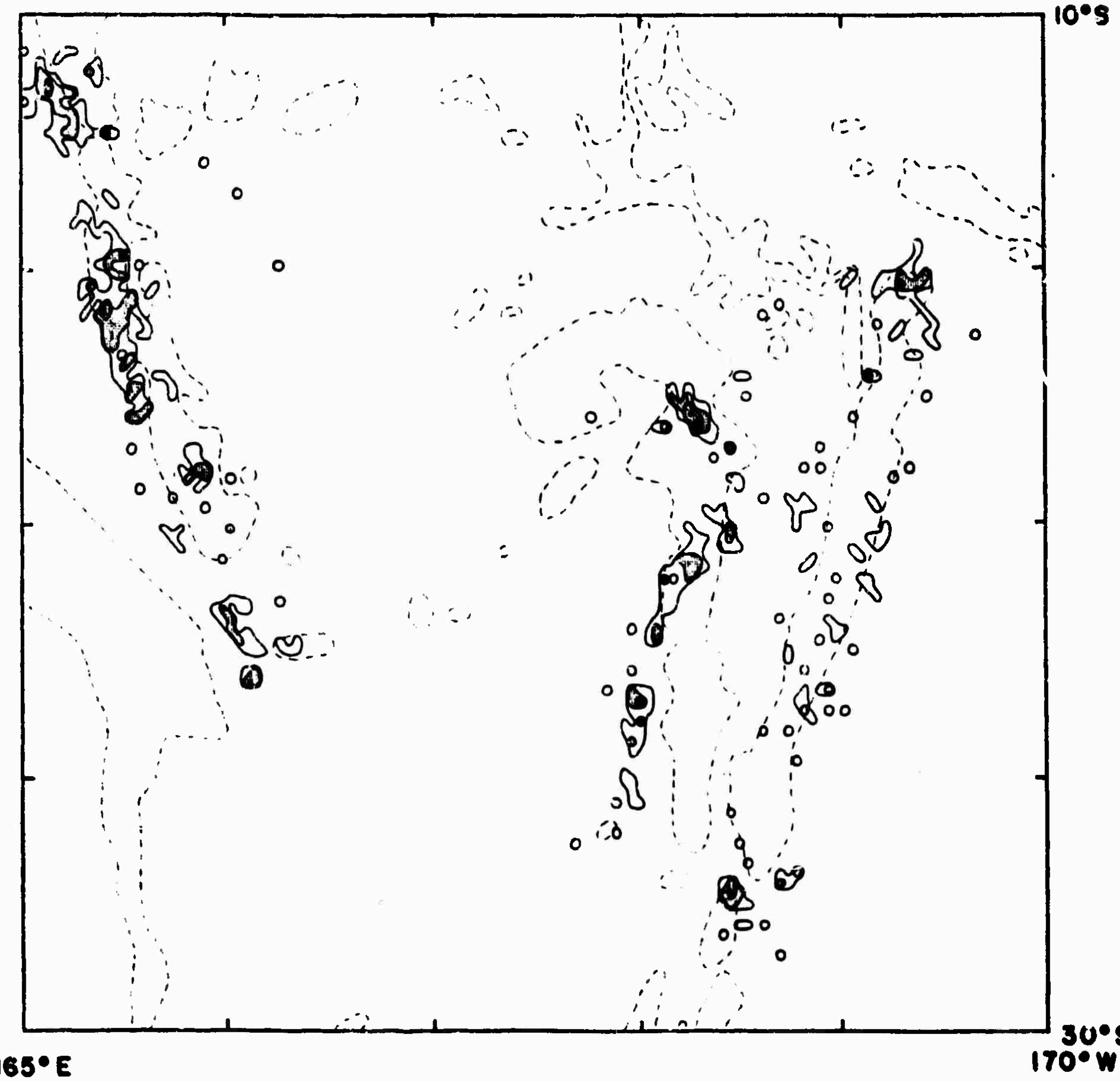

Fig. 1b. Earthquake epicenters in the Fiji-Tonga region. Dotted line is the 1000-fathom contour.

The geometry of the recording stations with respect to the source is a critical factor in estimating accuracy. Optimum geometry occurs where the source is inside the hydrophone array, however, because most seismic areas of the Pacific are on the rim of the basin (i.e., outside the hydrophone array), optimum geometry seldom occurs. When all stations lie on a line passing through the source, the distance to the source is impossible to compute and the azimuth is poorly defined. The sources computed for a series of events from a common radiator tend to be spread out in the shape of an ellipse with the major axis in the direction of the hydrophone array; the ellipse is a manifestation of the confidence regions and an indication of the error in source location. The T-phase source maps for the Kurile Islands (Fig. 2) and the Aleutians (Fig. 3) illustrate this fact. As geometry approaches optimum, the ellipse becomes more circular.

Systematic errors in source location may be caused by lack of knowledge of the sofar velocity in certain regions; the sofar velocity is well known only in the Northeast Pacific, where these errors are therefore probably negligible. But in the South Pacific, velocities are uncertain; this fact, combined with the effects of poor geometry, may cause source location in the South Pacific to be in error by several degrees. Most T-phase locations for earthquakes off the coast of California are probably accurate to two tenths of a degree, or better.

THRESHOLD

For nearly all regions which insonify the hydrophone array, the number of T phases located is greater than the number of C&GS epicenters for the same time period. The magnitude threshold for T-phase location in the Aleutian region has been estimated to be 0.7 magnitudes lower than that for C&GS epicenter location (Johnson & Northrop, 1966); however, this value varies with region. Another comparison between the number of earthquakes located by T phase and by body waves is shown in Table 1. Data in this table were compiled by converting T-phase strength to earthquake magnitude (Johnson & Northrop, 1966), and counting the number of earthquakes and T phases of the same magnitude (D. A. Walker, personal communication). It should be noted, however, that T-phase strength is only an approximate indication of magnitude.

DISCUSSION OF REGIONS

All published T-phase sources and C&GS earthquake epicenters found in the Pacific Basin from December 1964 through January 16, 1967, are plotted as event-density maps in Appendix A. Four regions of particular interest (Figs. 1, 2, 3, and 6) have been contoured and shaded according to source density. The first contour corresponds to two events per two-tenth-degree square, successive contours occurring at increases of powers of two in source density.

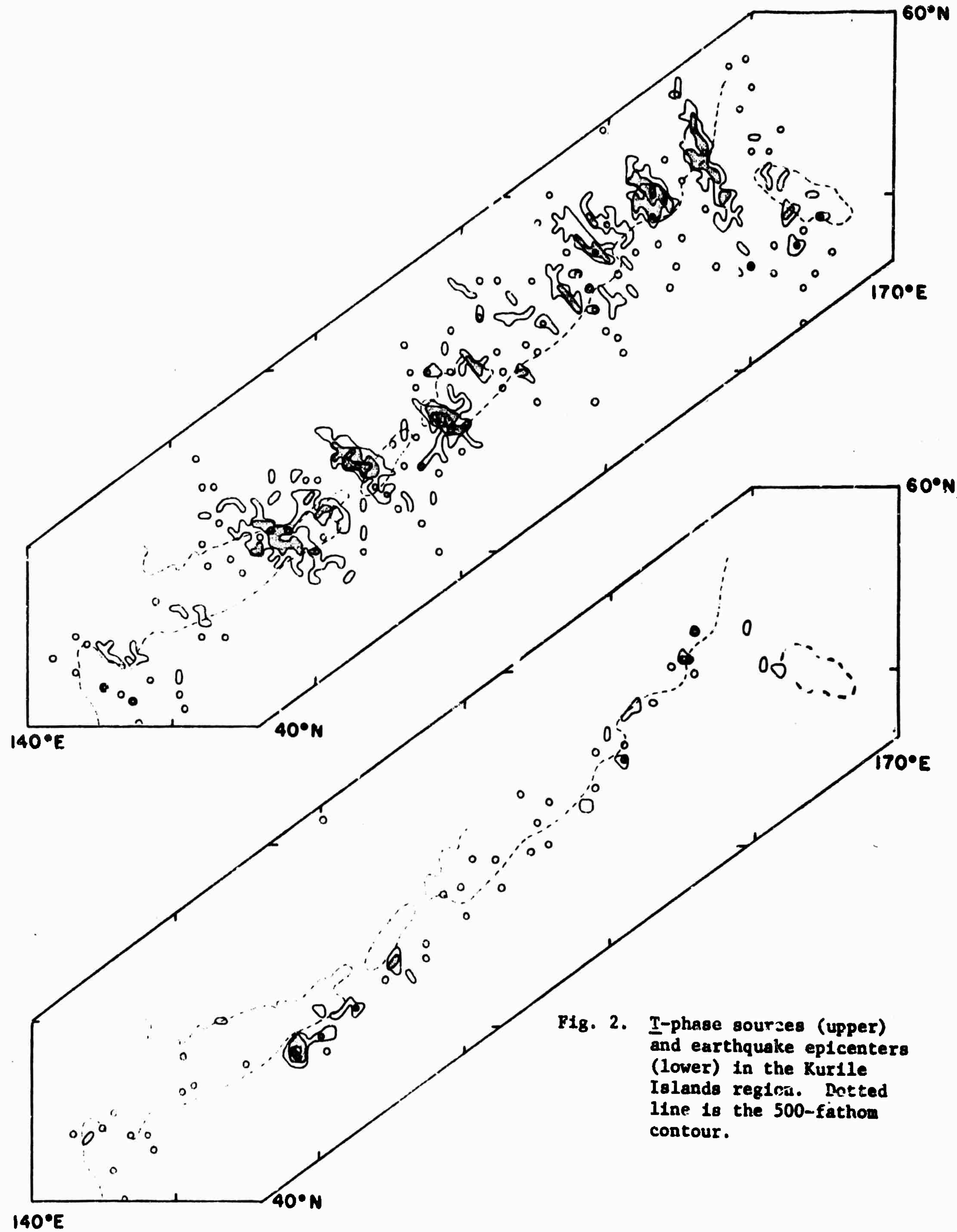

Fig. 2. T-phase sources (upper) and earthquake epicenters (lower) in the Kurile Islands region. Dotted line is the 500-fathom contour.

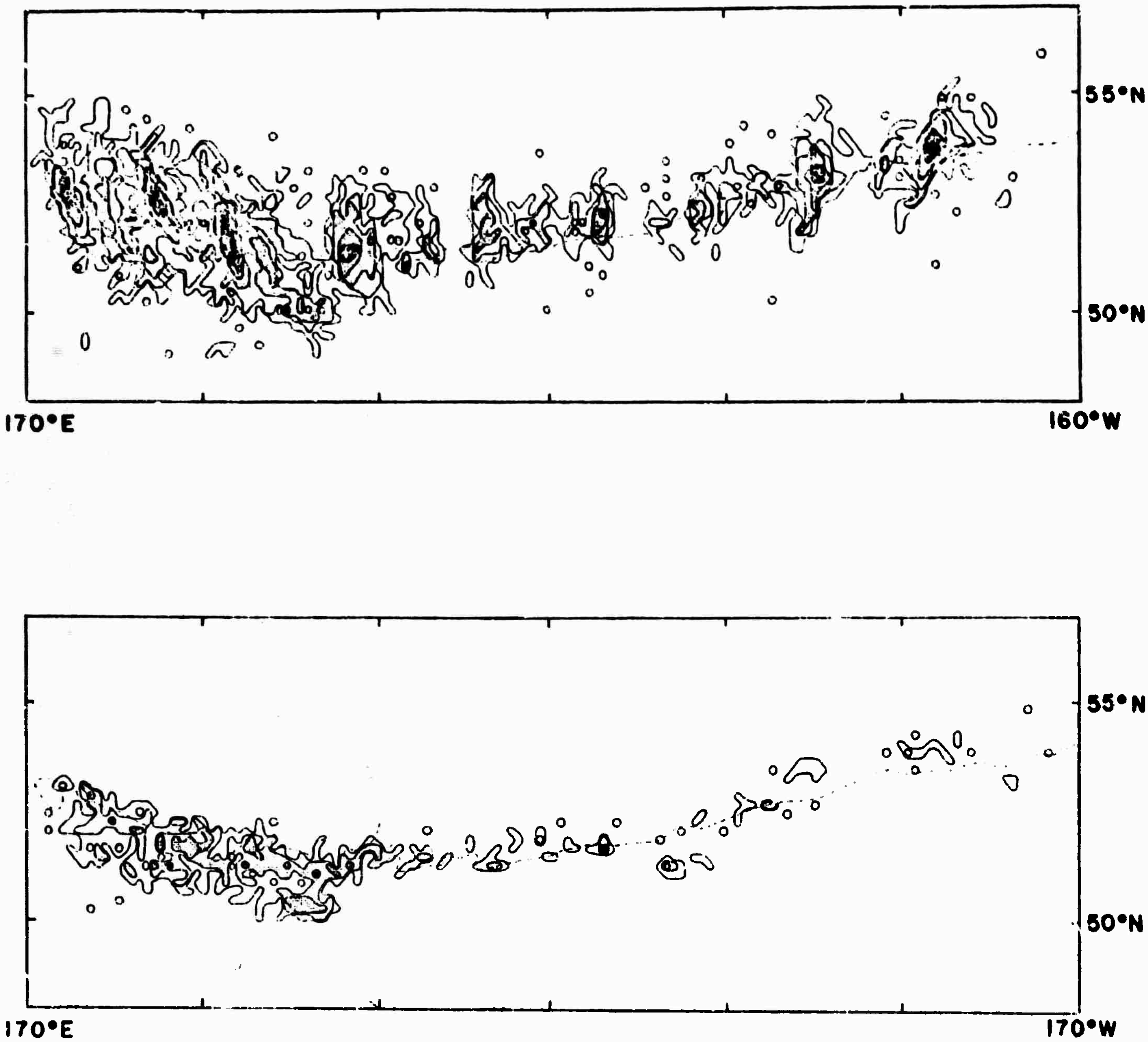

Fig. 3. T-phase sources (upper) and earthquake epicenters (lower) in the Aleutian Islands region. Dotted line is the 500-fathom contour.

Table 1. Comparison of T-phase Sources and Earthquake Epicenters

Magnitude	T-phase Sources	C&GS Earthquake Epicenters
	Mariana Islands to Komandorsky Island (1966)	
3.8	171	5
4.4	83	41
All magnitudes	2,098	467
	Aleutian Islands (1966)	
3.8	375	8
4.4	114	31
All magnitudes	3,794	431

Kurile Islands (Fig. 2): While most C&GS locations are found seaward of the 500-fathom contour, most T-phase locations are on the island slopes. T phases are most efficiently generated at places where the ocean bottom slopes seaward and intersects the sound-channel axis. Thus the P waves travel back to the slope before generating a T phase. The spreading of the T-phase locations approximately perpendicular to the shore is due to the geometry of the stations with respect to this region.

Aleutian Islands (Fig. 3): Approximately half of all T-phase sources located in the past two years are in the Aleutian region. The very high density of sources in the Eastern Aleutians is due, for the most part, to aftershocks of the Rat Islands earthquake of 4 February 1965. While the C&GS epicenters are scattered more or less randomly along the ridge, the T-phase sources are clustered in specific areas. It is believed that these areas of high density delineate bottom topography which is more favorable to T-phase radiation than are surrounding areas (Johnson & Norris, 1966).

In areas where the ocean bottom does not intersect the sound channel, abyssal T phases are generated which radiate directly from the epicenter; sound energy probably enters the sofar channel by scattering from the ocean surface (Johnson, Norris, and Duennebier, in press). Many of the Rat Islands aftershocks originated under the deep ocean floor. Listed in Table 2 are 55 of these which occurred between March 29 and April 6 in the region bounded by 177 E, 179 E, 49.5 N, and 51 N. As shown in Figure 4, the T-phase source locations were generally 40 km to the south of the corresponding earthquake epicenters. (The correspondence is indicated in Table 2).

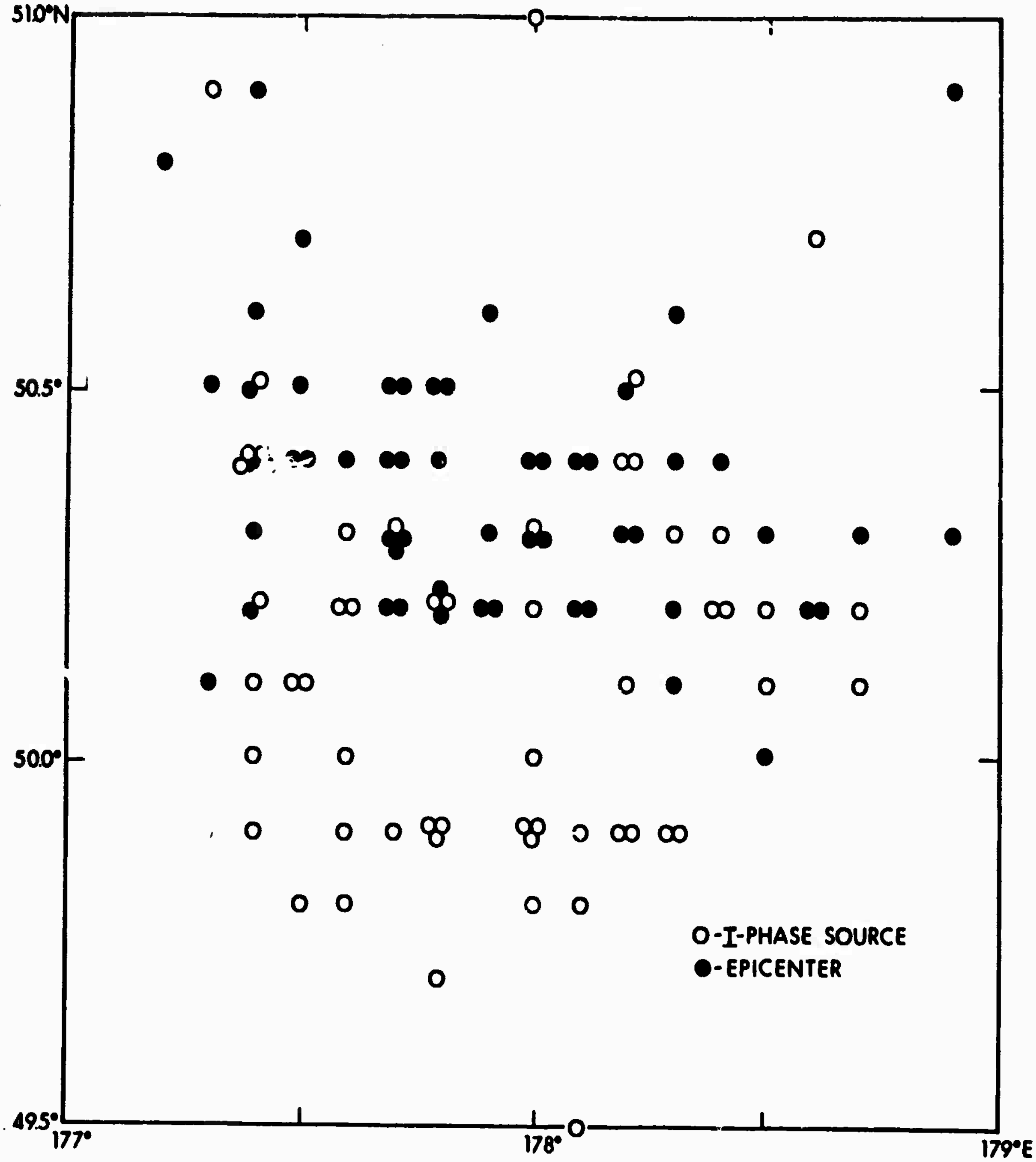

Fig. 4. Source locations south of Amchitka Island from March 29 to April 6, 1965.

The generation of T phases in abyssal regions has been described by Johnson, Norris, and Duennebier (in press). They concluded that the probable mechanism of transformation of energy from the near vertically traveling seaquake to the near horizontally traveling T phase was scattering at the ocean surface. This mechanism places the abyssal T-phase source at the earthquake epicenter where the seaquake is most intense. The systematic discrepancies noted in the preceding paragraph must be ascribed either to systematic errors in T-phase source locations or to systematic errors in earthquake epicenter locations or to inaccuracy in the abyssal T-phase model.

Body-wave source solutions give very accurate origin times for earthquakes but less accuracy in position. For an accurate T-phase source, one would expect the origin time to be about 10 seconds later than the origin time of the earthquake, the difference being the vertical travel time from the earthquake focus to the sound channel. For the events shown in Figure 4, the computed T-phase origin time was, on the average, 1.1 seconds earlier than the epicenter time with a standard deviation of 18.5 seconds; the actual distribution is shown in Figure 5. Using a T-phase velocity greater than the actual velocity in calculating source locations would cause the T-phase sources to be displaced towards the hydrophone array, as in this case, but such an error would also cause the T-phase origin times to be later than the earthquake origin times. A 40-km error in T-phase source location would induce an origin time error of approximately 30 seconds. Such a systematic error is not supported by the data; therefore the systematic difference in source position cannot be attributed to a velocity error. An indication that the body-wave-derived locations are systematically north of their actual positions is provided by the Longshot nuclear explosion. The computed epicenter for this event was 25 km northwest of the actual explosion point on Amchitka Island (Herrin and Taggart, 1966).

Fiji-Tonga (Fig. 1): This region was included to show how inadequate the T-phase coverage is in this region, due both to blocking of various stations by island groups and to poor geometry. This situation could be improved by installation of a hydrophone station at a favorable south Pacific location.

California (Fig. 6): In this region, near-optimum geometry gives rise to excellent T-phase location. Contrary to earlier findings (Johnson, Norris, and Duennebier, in press), several T phases from this region have been recognized as being abyssally generated, thus T-phase sources just north of the Mendocino Escarpment should correspond to earthquake epicenters. A highly seismic area is well defined by the T-phase map although C&GS epicenter locations for this time span do not have a high enough density to define this seismic area. This area has been studied by many investigators concerned with transform faulting and the northern extension of the East Pacific Rise (Talwani *et al.*, 1965; Menard, 1964; Wilson, 1965). As seismic evidence has been sketchy, they have had to rely primarily on magnetic and topographic evidence. T-phase sources are very dense and probably are more accurate than the C&GS locations for this region. Thus they should provide a useful supplement to the study of tectonic processes.

Table 2. Source Data for T Phase (upper line) and Earthquake Epicenter (lower line) for the Events Shown in Figure 4

D	H	M	S	LAT	LONG	DEPTH	STRENGTH	MAG
				March 1965				
29	17	35	15	50.2 N	178.7 E		21	
29	17	35	16	50.3 N	178.5 E	40		4.3
30	0	51	43	50.3 N	178.4 E		16	
30	0	51	48	50.3 N	177.7 E	33		4.1
30	4	51	6	50.2 N	177.8 E		24	
30	4	51	13	50.4 N	178.0 E	33		3.8
30	6	25	10	49.9 N	177.4 E		29	
30	6	25	1	50.1 N	177.3 E	30		5.2
30	6	51	58	49.7 N	177.8 E		19	
30	6	51	39	50.8 N	177.2 E	33		4.0
30	6	55	27	50.5 N	177.4 E		19	
30	6	55	15	50.9 N	177.4 E	33		4.3
30	7	10	59	49.9 N	177.8 E		29	
30	7	10	53	50.2 N	177.8 E	35		4.9
30	7	21	23	49.9 N	177.8 E		30	
30	7	21	11	50.2 N	177.7 E	33		5.0
30	7	40	55	50.0 N	177.6 E		23	
30	7	40	38	50.3 N	177.4 E	32		4.7
30	8	1	35	50.0 N	178.0 E		16	
30	8	1	27	50.3 N	177.9 E	30		4.5
30	8	11	19	50.3 N	177.6 E		24	
30	8	11	7	50.5 N	177.5 E	35		4.7
30	8	35	44	49.9 N	178.0 E		17	
30	8	35	35	50.3 N	178.0 E	30		4.1
30	8	54	22	49.9 N	178.2 E		20	
30	8	54	18	50.1 N	178.3 E	33		4.3
30	9	5	24	49.9 N	177.8 E		26	
30	9	5	13	50.2 N	177.9 E	38		4.7
30	9	52	28	50.2 N	177.6 E		15	
30	9	52	22	50.9 N	178.0 E	43		4.3
30	9	54	21	50.2 N	177.8 E		21	
30	9	54	27	50.2 N	177.8 E	33		4.1
30	11	16	5	49.9 N	177.7 E		14	
30	11	15	32	50.5 N	177.7 E	30		4.4
30	14	8	47	50.2 N	177.6 E		23	
30	14	8	34	50.7 N	177.5 E	35		4.0
30	14	57	14	50.1 N	177.5 E		15	
30	14	57	5	50.5 N	177.8 E	47		4.1
30	15	5	54	49.8 N	178.0 E		21	
30	15	6	50	50.6 N	177.4 E	33		3.9
30	17	39	5	51.0 N	178.0 E		28	
30	17	39	57	50.2 N	178.1 E	30		4.4
30	18	9	30	50.1 N	177.5 E		18	
30	18	9	27	50.4 N	177.5 E	33		4.1
30	21	16	54	50.4 N	178.2 E		23	
30	21	17	11	50.4 N	178.1 E	23		4.6
30	21	29	1	50.2 N	177.4 E		17	
30	21	29	5	50.4 N	177.5 E	33		4.2
31	0	29	30	50.3 N	178.0 E		24	
31	0	29	46	50.5 N	177.8 E	33		4.3
31	5	4	4	50.2 N	178.0 E		19	
31	5	4	14	50.5 N	178.2 E	35		4.0
31	6	46	18	49.9 N	178.0 E		27	
31	6	46	13	50.4 N	177.7 E	33		4.2
31	10	45	50	50.3 N	178.2 E		31	
31	10	46	9	50.3 N	178.2 E	30		5.6

31	15	20	16	49.8 N	178.6 E		21	
31	15	20	4	50.2 N	178.7 E	33		4.5
31	15	48	40	50.4 N	177.4 E		18	
31	15	49	9	50.9 N	178.9 E	25		4.3
31	15	54	11	50.4 N	177.4 E		22	
31	15	54	33	50.5 N	177.4 E	30		4.5
31	17	15	37	49.9 N	177.6 E		22	
31	17	15	2	50.4 N	177.7 E	33		4.1
31	19	38	31	49.8 N	177.5 E		19	
31	19	38	8	50.5 N	177.7 E	47		4.6
31	19	48	43	49.9 N	178.3 E		22	
31	19	48	30	50.3 N	178.0 E	25		4.9
31	21	10	7	49.7 N	178.1 E		20	
31	21	9	50	50.8 N	179.1 E	33		4.4
31	21	13	43	49.9 N	178.0 E		26	
31	21	13	30	50.2 N	177.9 E	30		4.8
31	21	22	59	49.9 N	178.3 E		18	
31	21	22	51	50.3 N	178.2 E	30		4.6
31	23	48	58	49.5 N	178.1 E		30	
31	23	48	22	50.3 N	177.7 E	25		4.7

April 1965

1	2	37	9	49.8 N	178.1 E		15	
1	2	36	48	50.6 N	177.9 E	25		4.2
1	4	41	31	50.4 N	177.4 E		11	
1	4	41	51	50.4 N	177.6 E	33		4.0
2	16	9	32	50.0 N	177.4 E		14	
2	16	9	28	50.5 N	177.4 E	31		4.4
2	16	28	21	5011 N	177.4 E		17	
2	16	28	22	50.4 N	177.4 E	35		5.2
2	16	59	2	50.4 N	177.4 E		22	
2	16	59	16	50.2 N	177.4 E	13		4.3
2	17	0	9	50.9 N	177.3 E		16	
2	17	1	2	50.4 N	177.8 E	48		4.2
2	20	25	13	50.3 N	177.7 E		16	
2	20	25	29	50.3 N	177.7 E	33		4.1
3	19	16	33	50.5 N	178.2 E		15	
3	19	17	1	50.6 N	178.3 E	33		4.0
4	7	6	17	50.3 N	178.3 E		20	
4	7	6	30	50.4 N	178.3 E	3		4.1
4	8	49	56	50.2 N	178.4 E		26	
4	8	50	6	50.4 N	178.4 E	33		3.7
4	10	59	28	50.1 N	178.2 E		20	
4	10	59	26	50.4 N	178.1 E	14		4.3
4	11	59	29	50.2 N	178.5 E		22	
4	11	59	34	50.2 N	178.6 E	33		3.8
4	22	47	50	50.7 N	178.6 E		19	
4	22	48	24	50.2 N	178.6 E	20		4.7
5	15	32	54	49.9 N	178.2 E		17	
5	15	32	50	50.2 N	178.1 E	33		4.1
5	21	8	25	50.1 N	178.7 E		19	
5	21	8	39	50.3 N	178.9 E	29		4.4
6	10	47	33	50.2 N	178.4 E		13	
6	10	47	55	50.0 N	178.5 E	33		4.0
6	13	30	55	49.9 N	178.1 E		30	
6	13	30	45	50.2 N	178.3 E	35		4.4

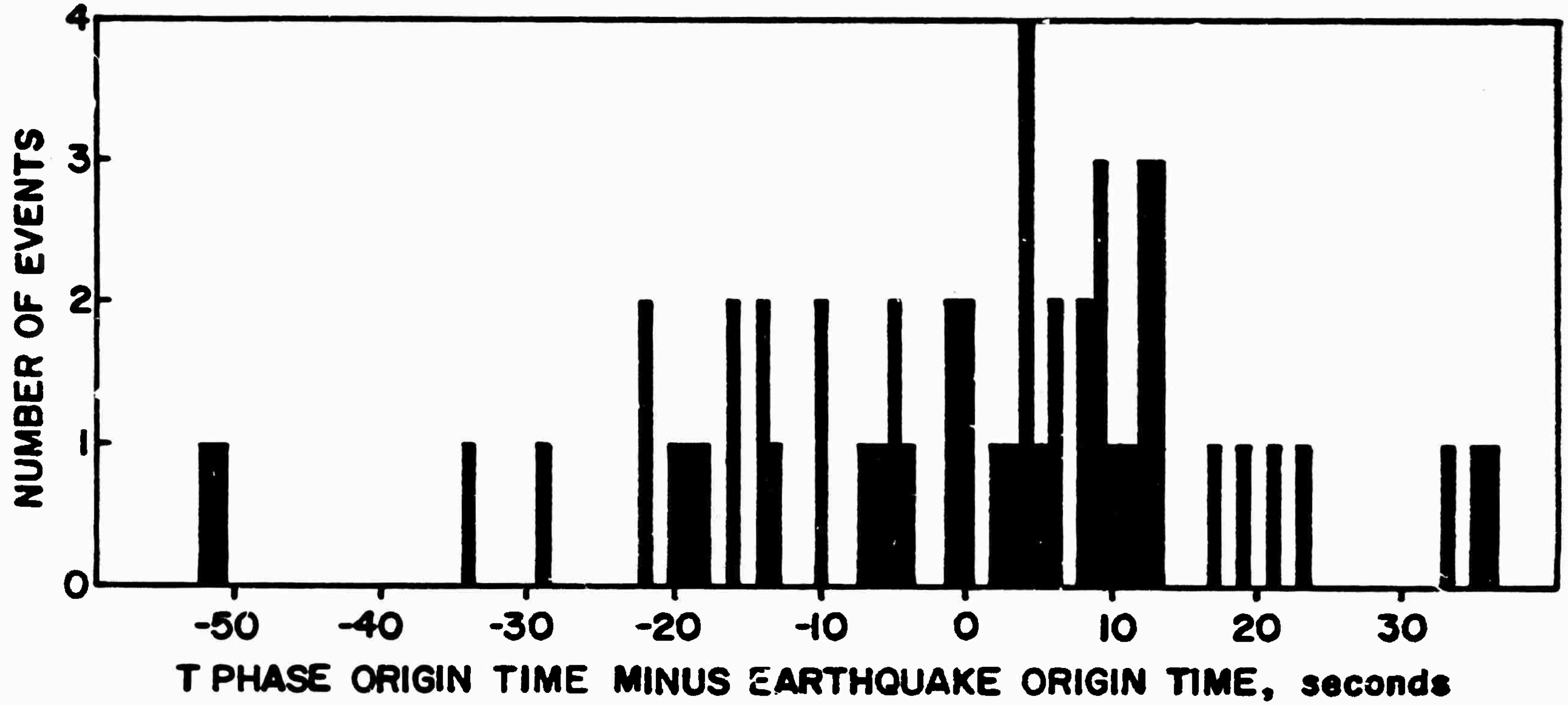

Fig. 5. Comparison of origin times of T phases and earthquakes for events shown in Figure 4.

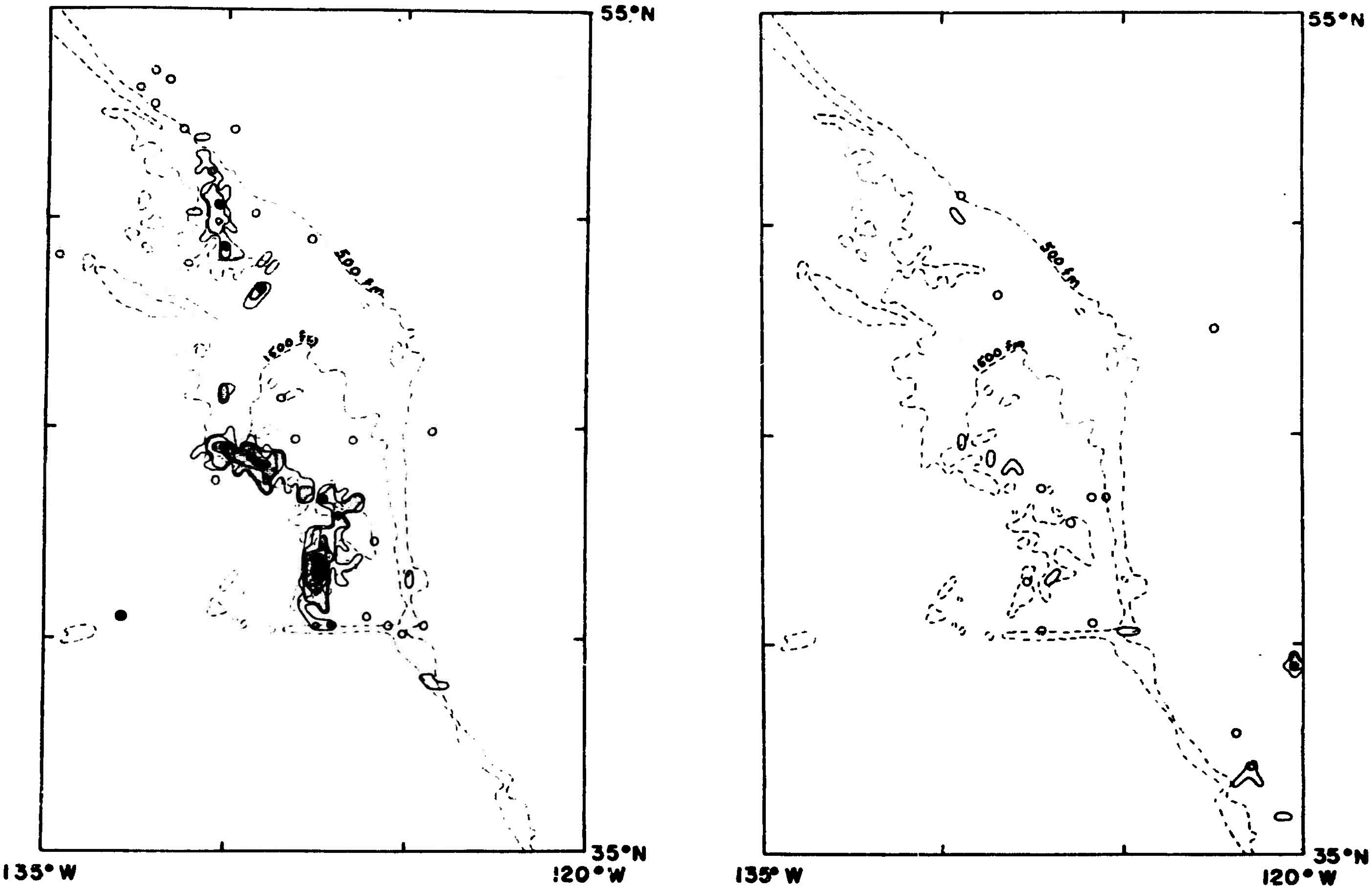

Fig. 6. T-phase sources (left) and earthquake epicenters (right) off the California-Oregon coast. Dotted lines are the 500- and 1500-fathom contours.

CONCLUSION

It has been shown that the use of the _T_ phase in seismic source location significantly improves the detection of earthquakes in the Pacific. In regions where geometry is favorable between the source and the hydrophone network, accurate source location is possible. The lower threshold of detection of _T_ phases allows more data on seismicity to be collected in a shorter time. An array of hydrophones favorably located in the South Pacific and Indian oceans would improve knowledge of seismicity in those regions.

ACKNOWLEDGMENTS

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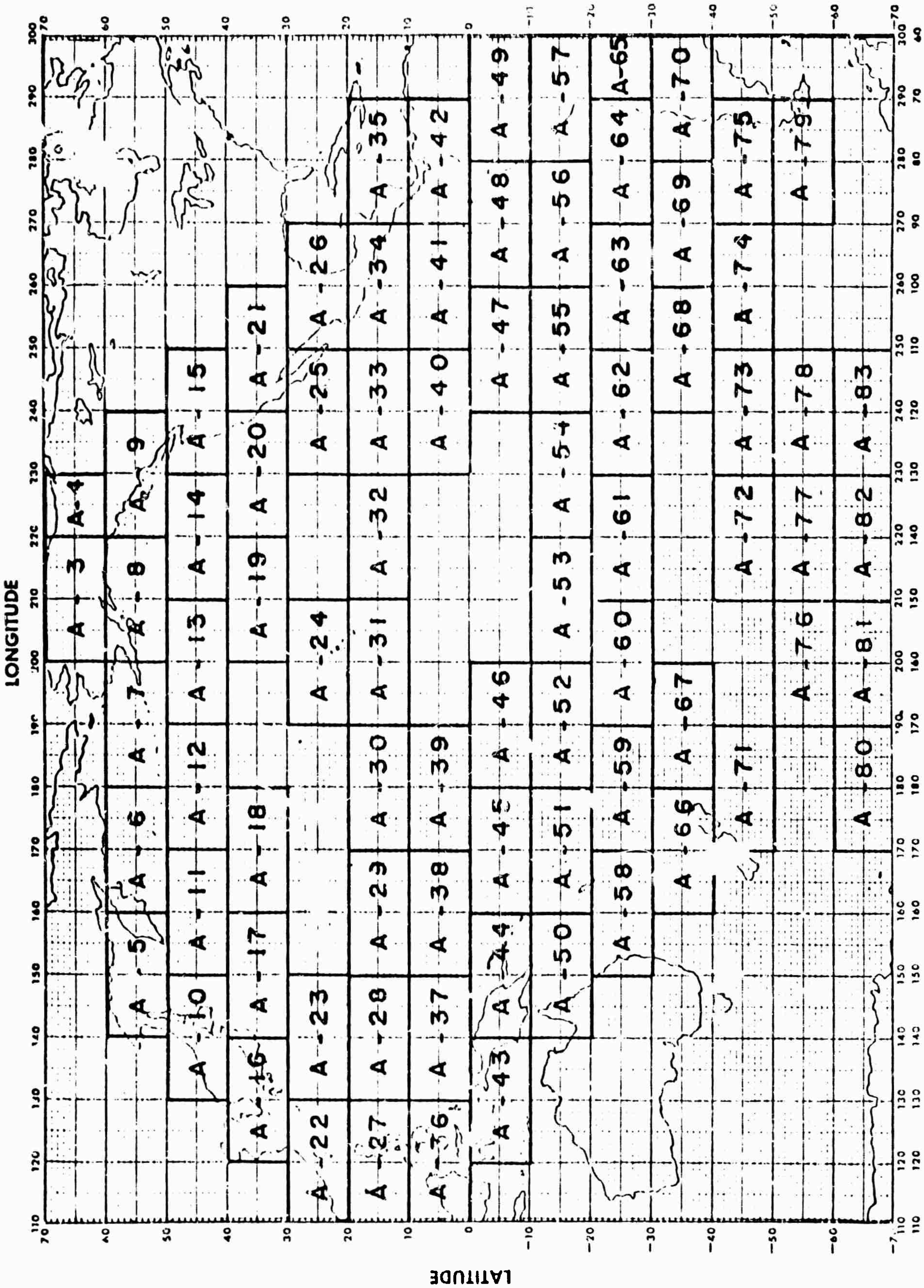
Appendix A

All regions where _T_-phase sources were located in the Pacific for the 2-year period covered are included in the appendix. On each page are two maps of the same 10-degree by 20-degree region; the upper map is of _T_-phase sources; the lower map is C&GS earthquake epicenters. The numbers are the characteristic of the logarithm, to base two, of the number of events in a two-tenth-degree square; thus a zero corresponds to one event, a one corresponds to two or three events, etc. The number at the top of each two-tenth-degree latitudinal section is the number of events represented by the largest number in that section; regions where no _T_-phase sources or epicenters were found are not included. An index map appears on page A-2.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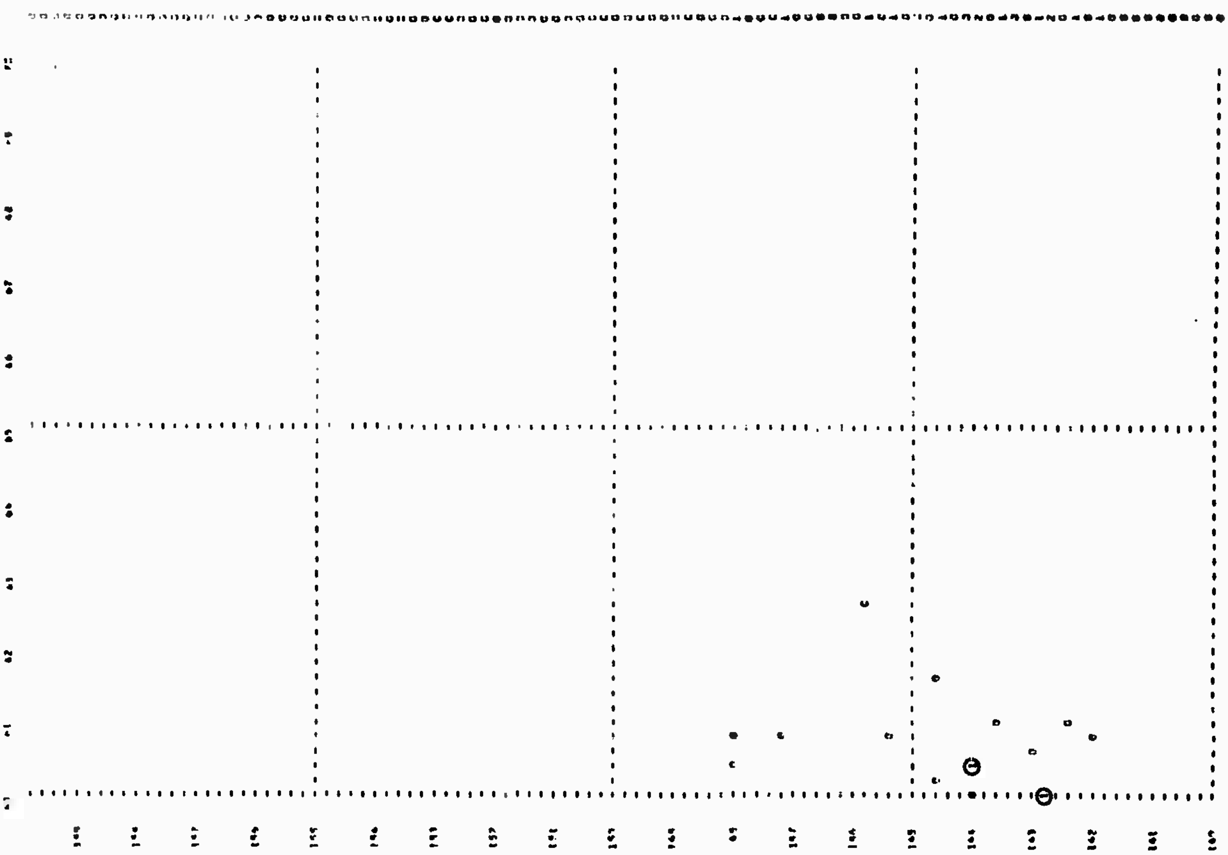
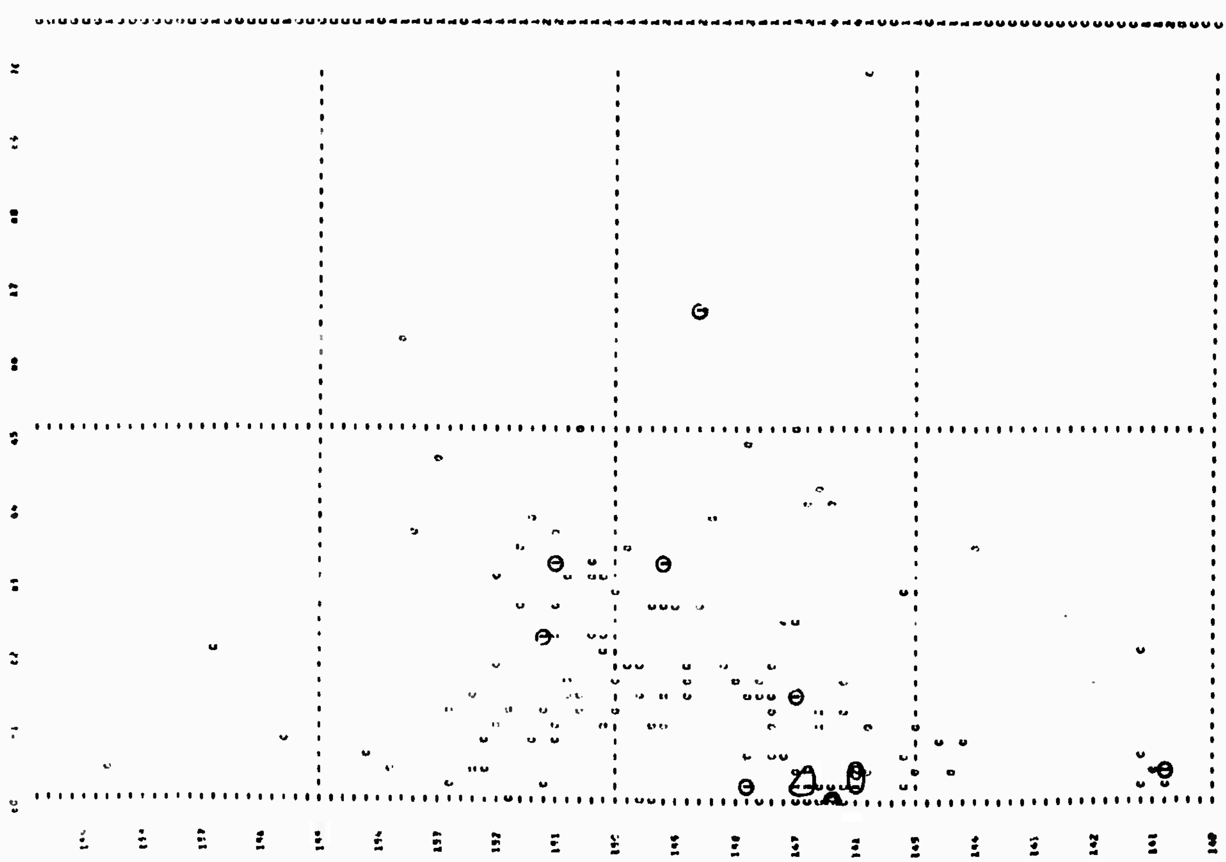
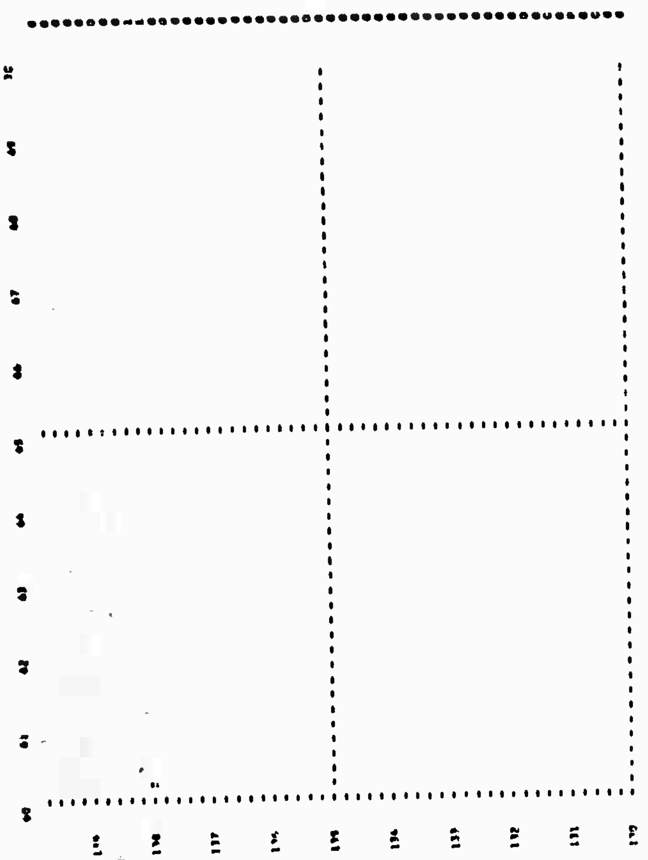
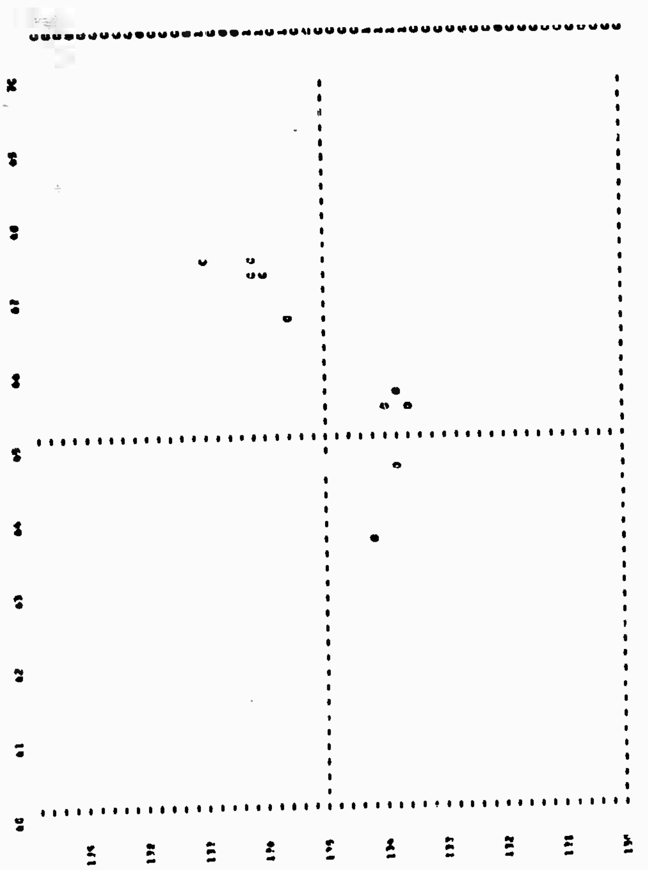
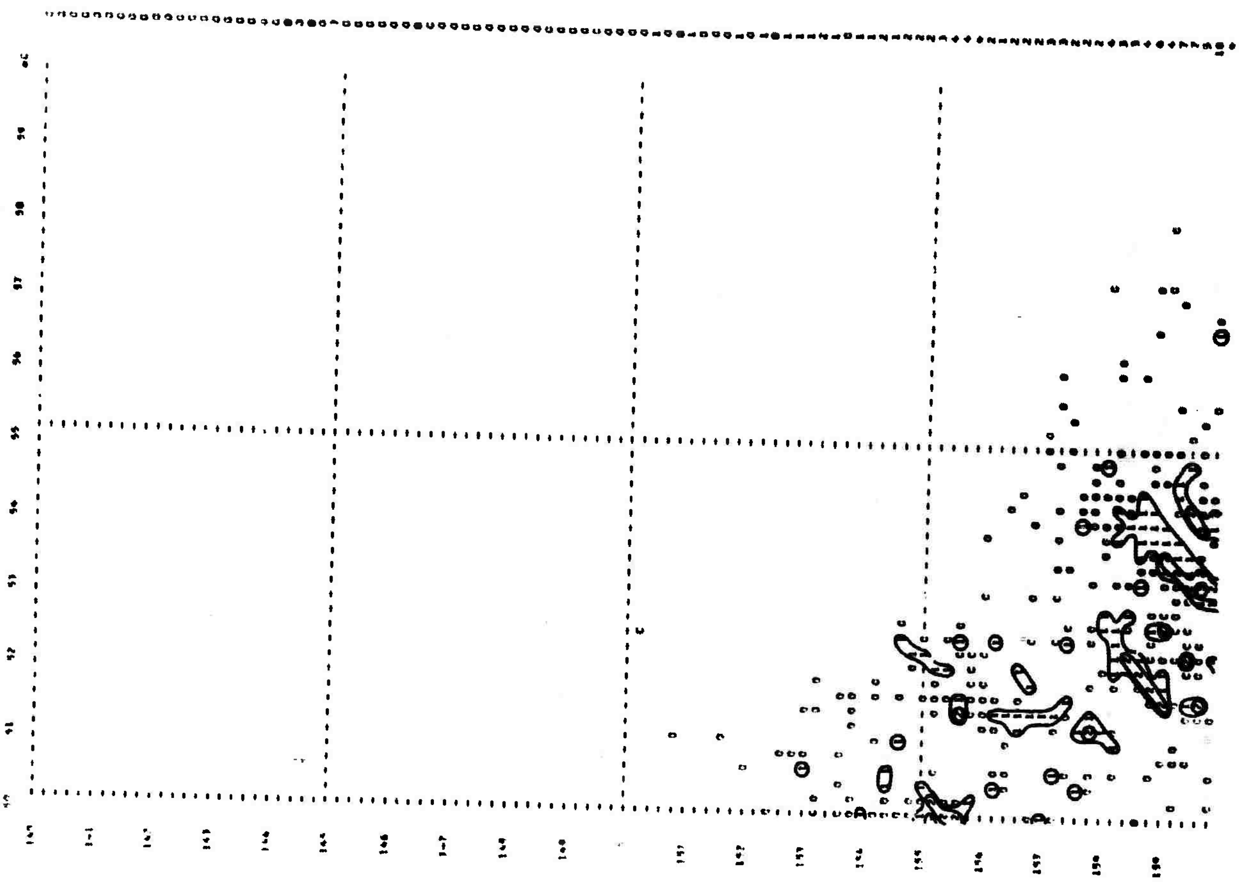
Index map

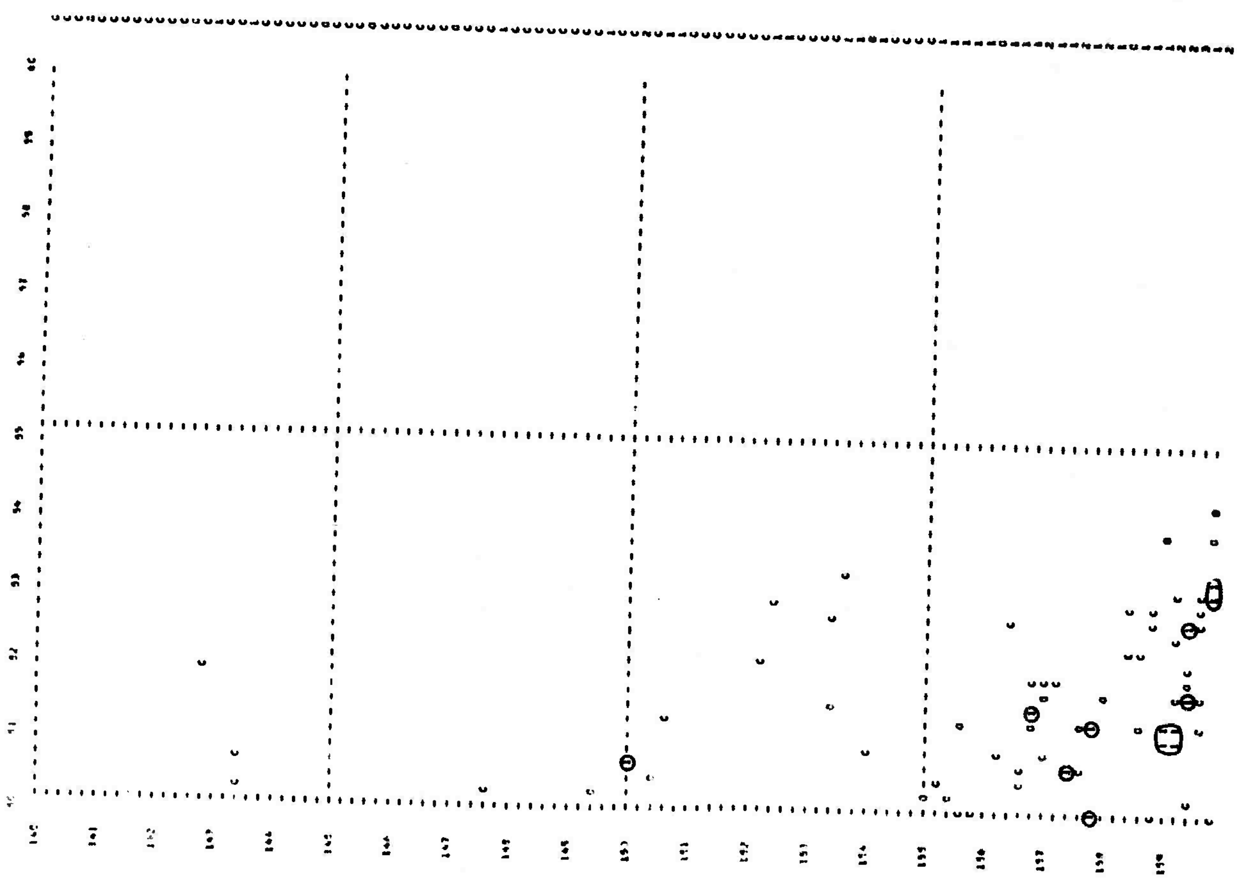


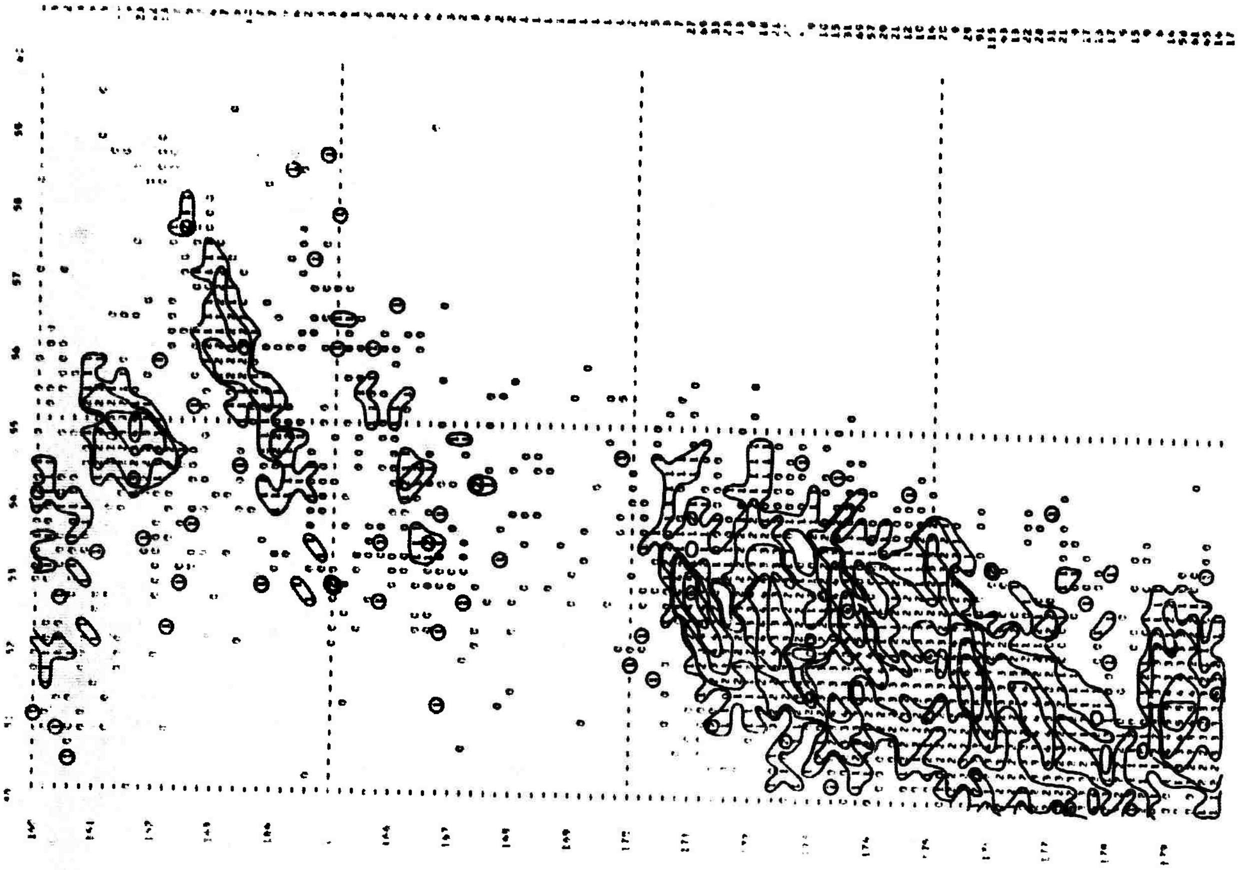


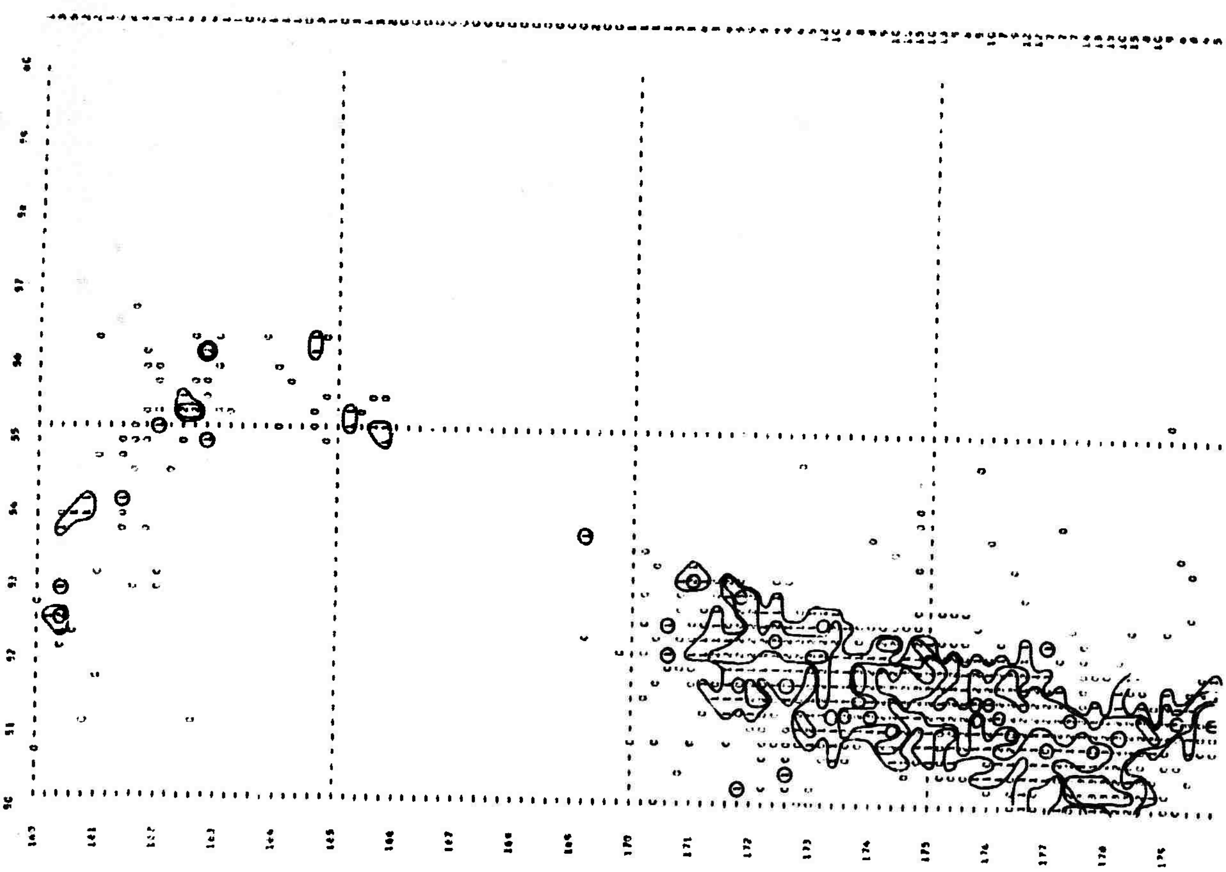


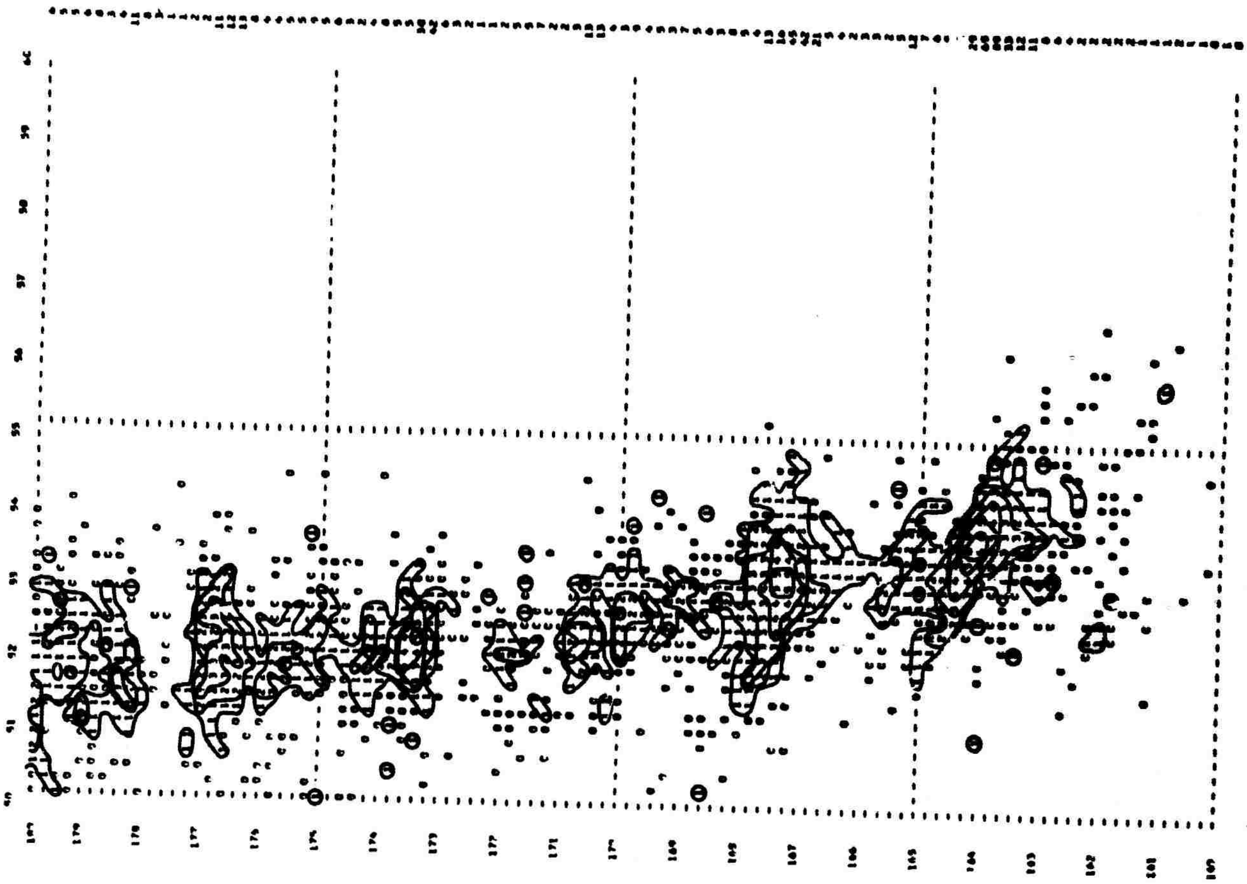


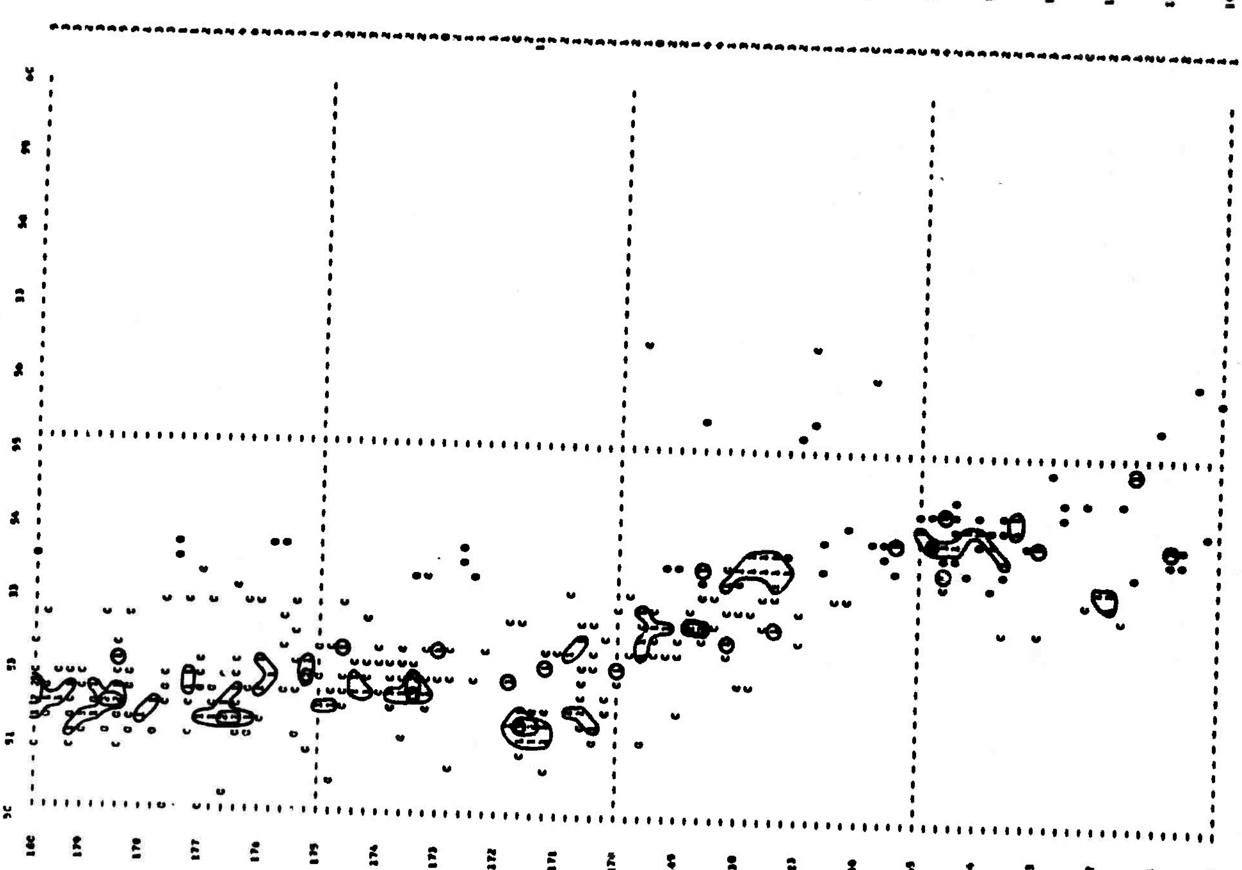


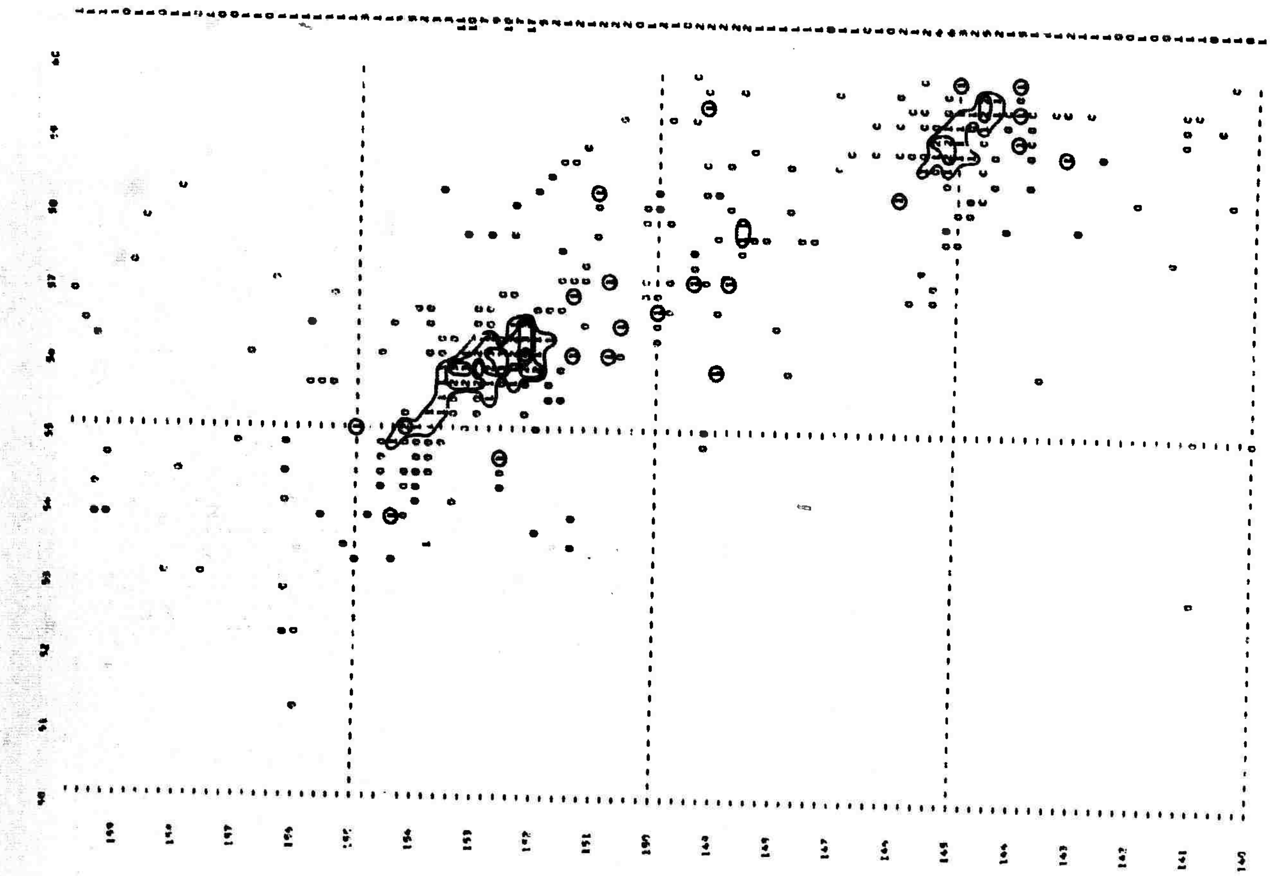


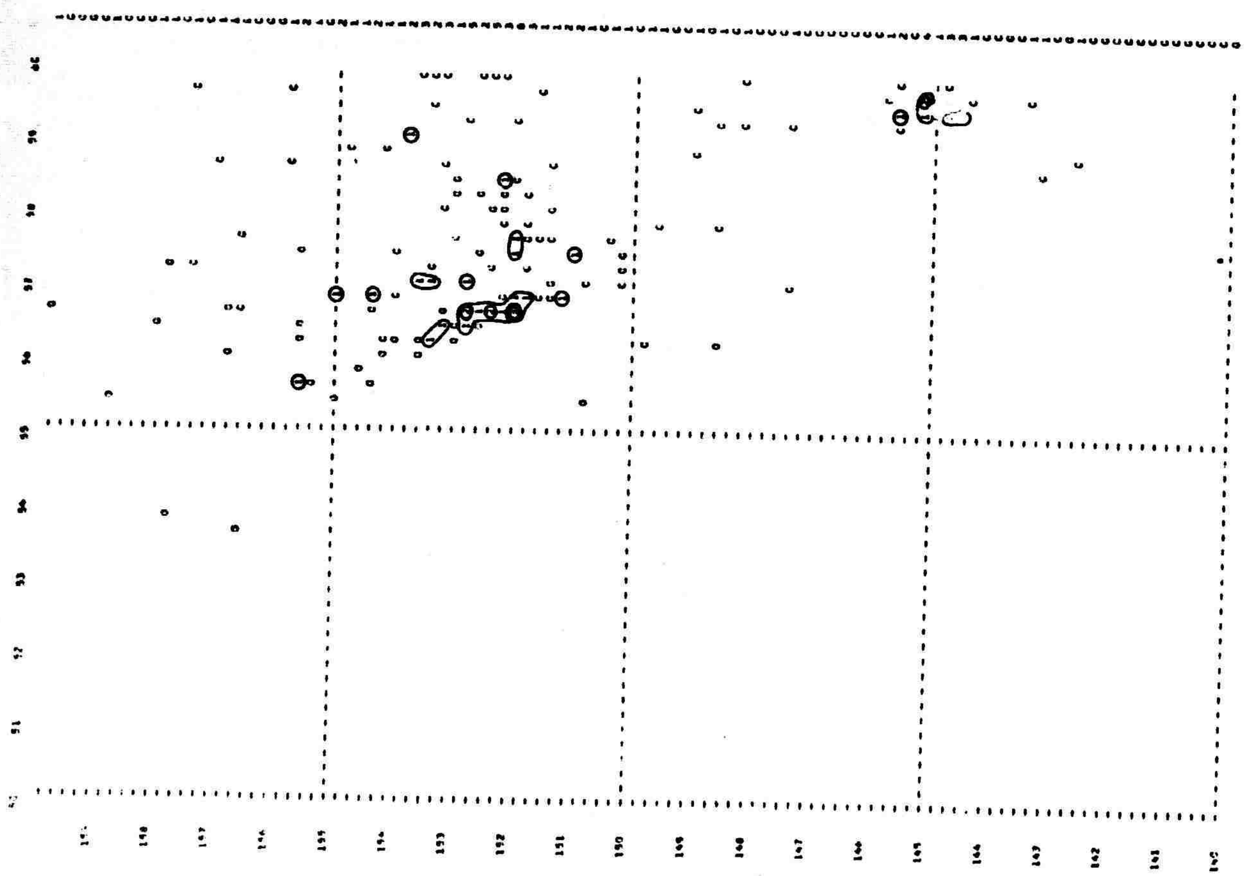


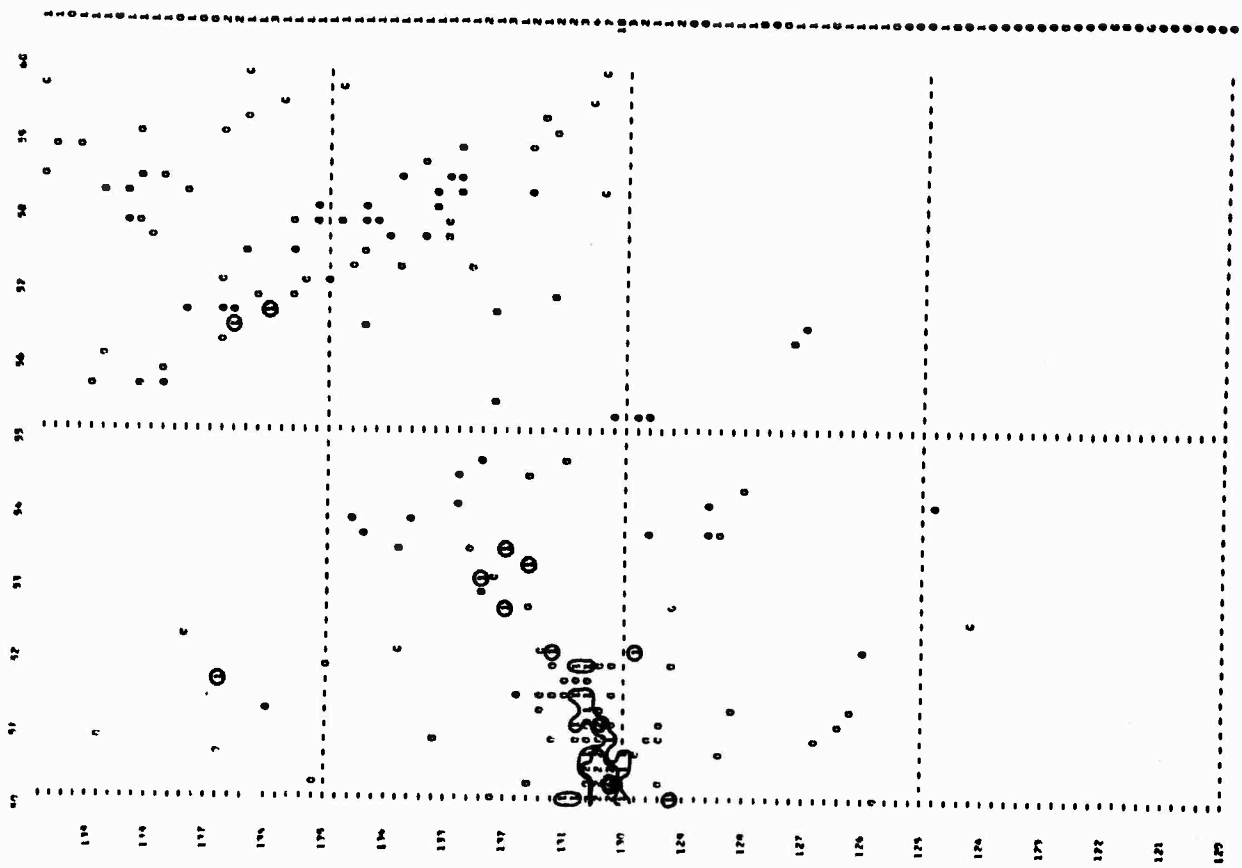


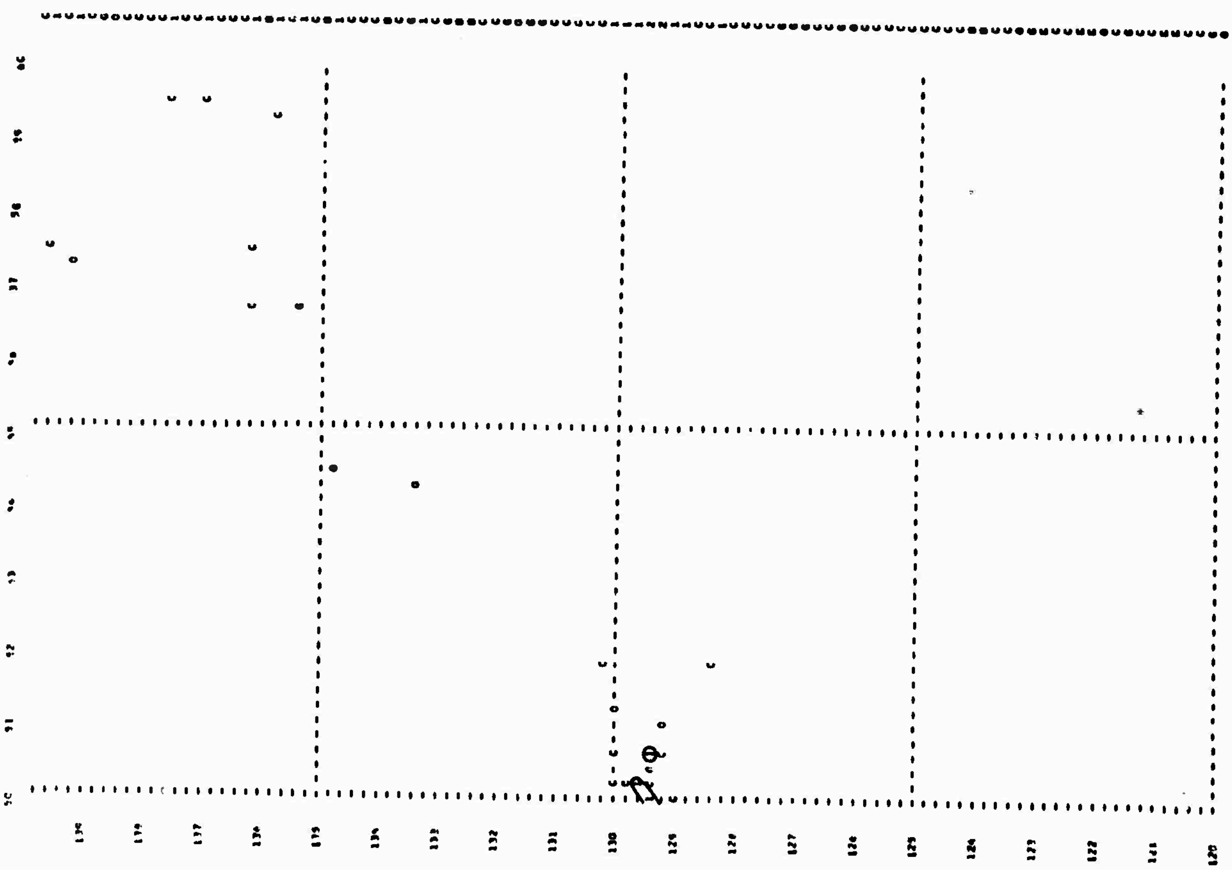


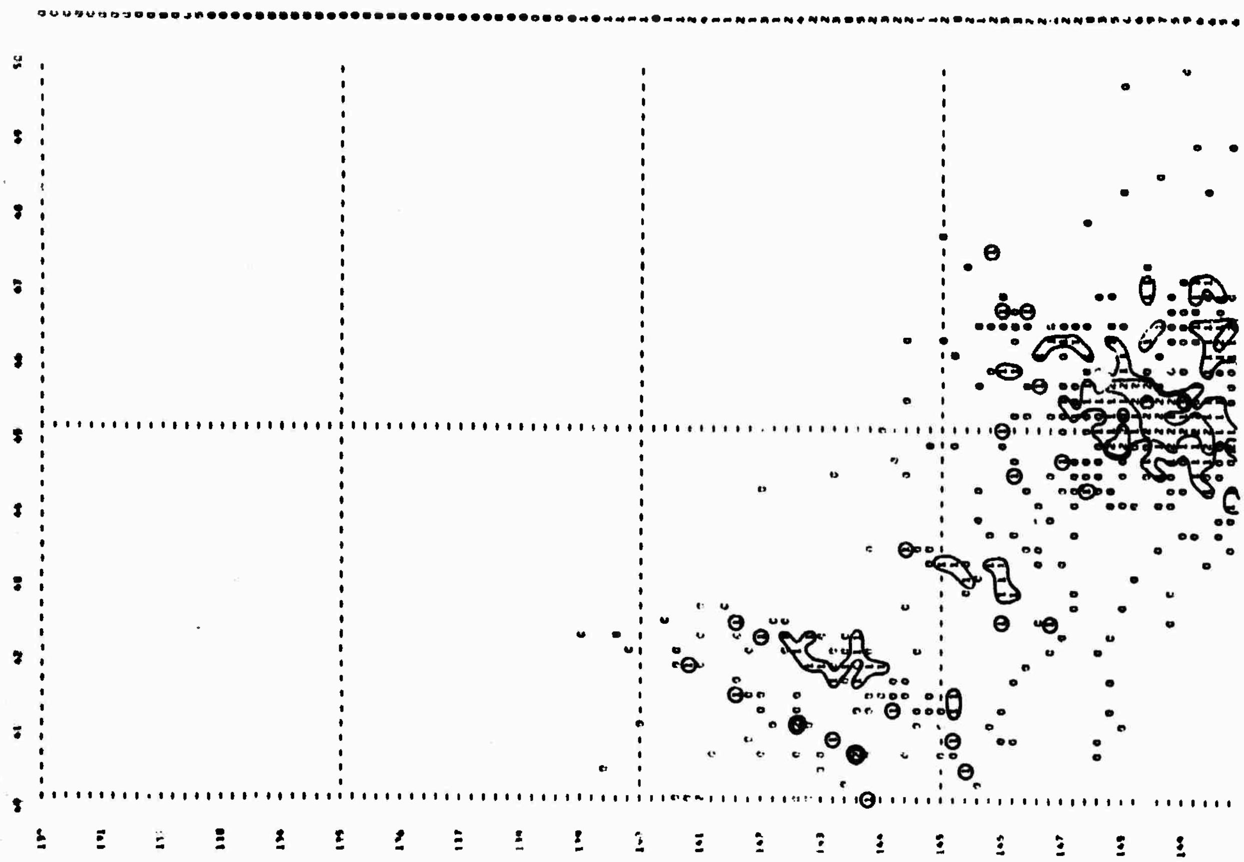


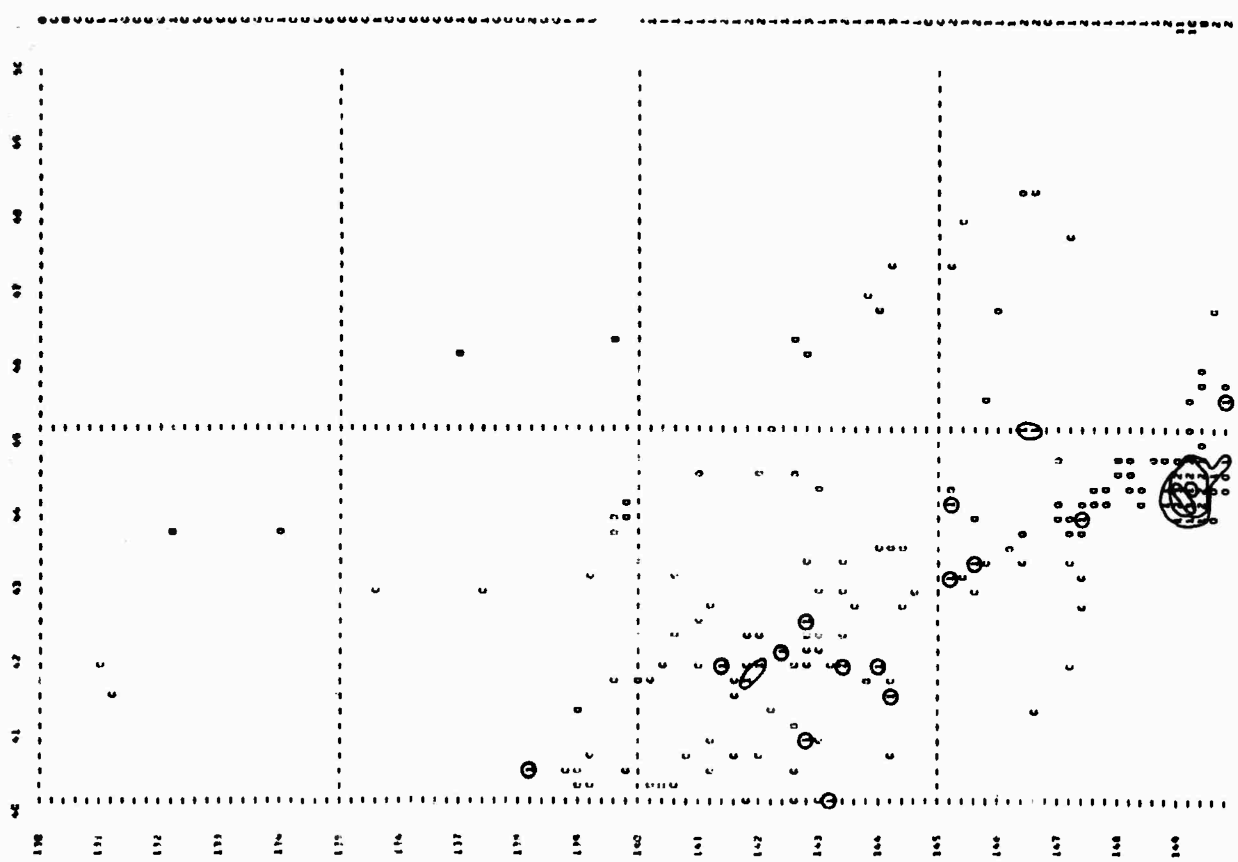


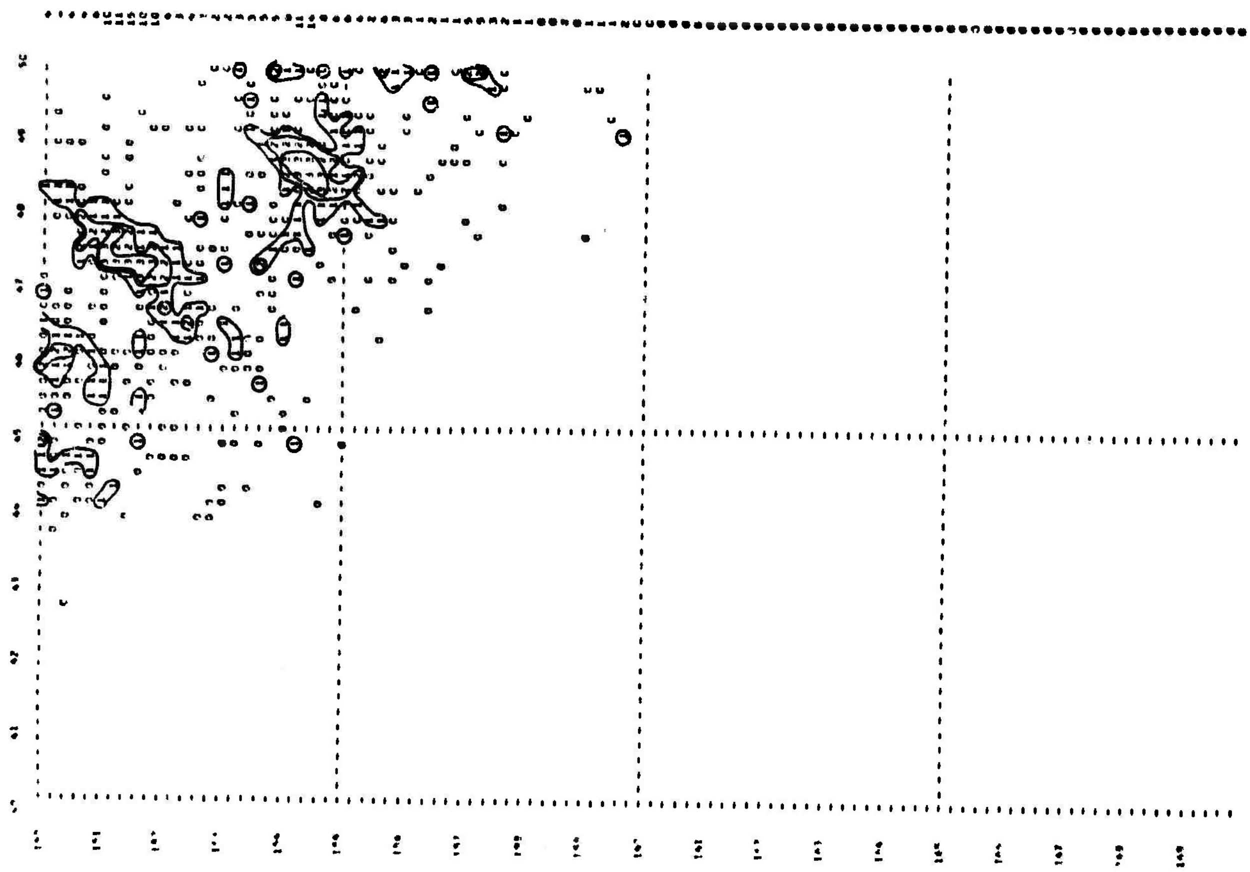


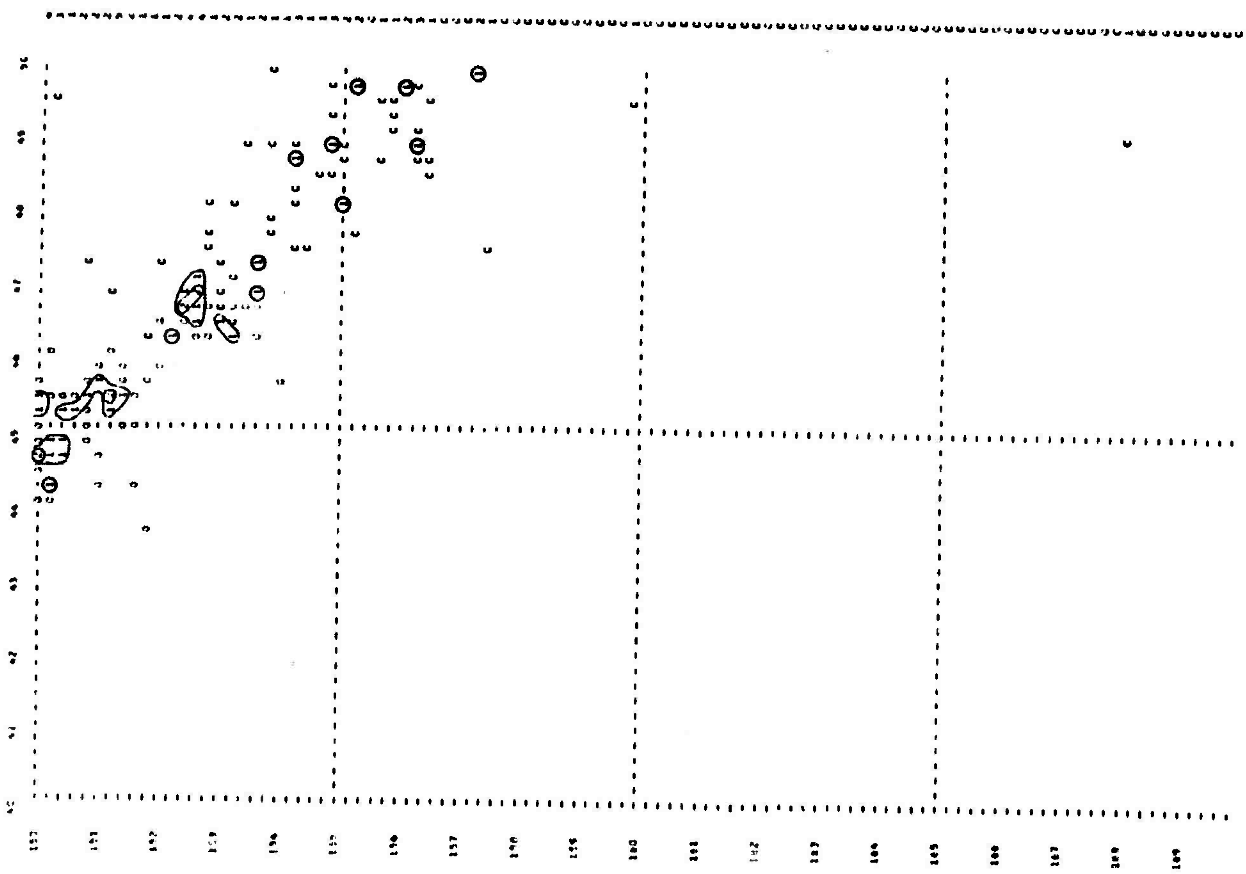


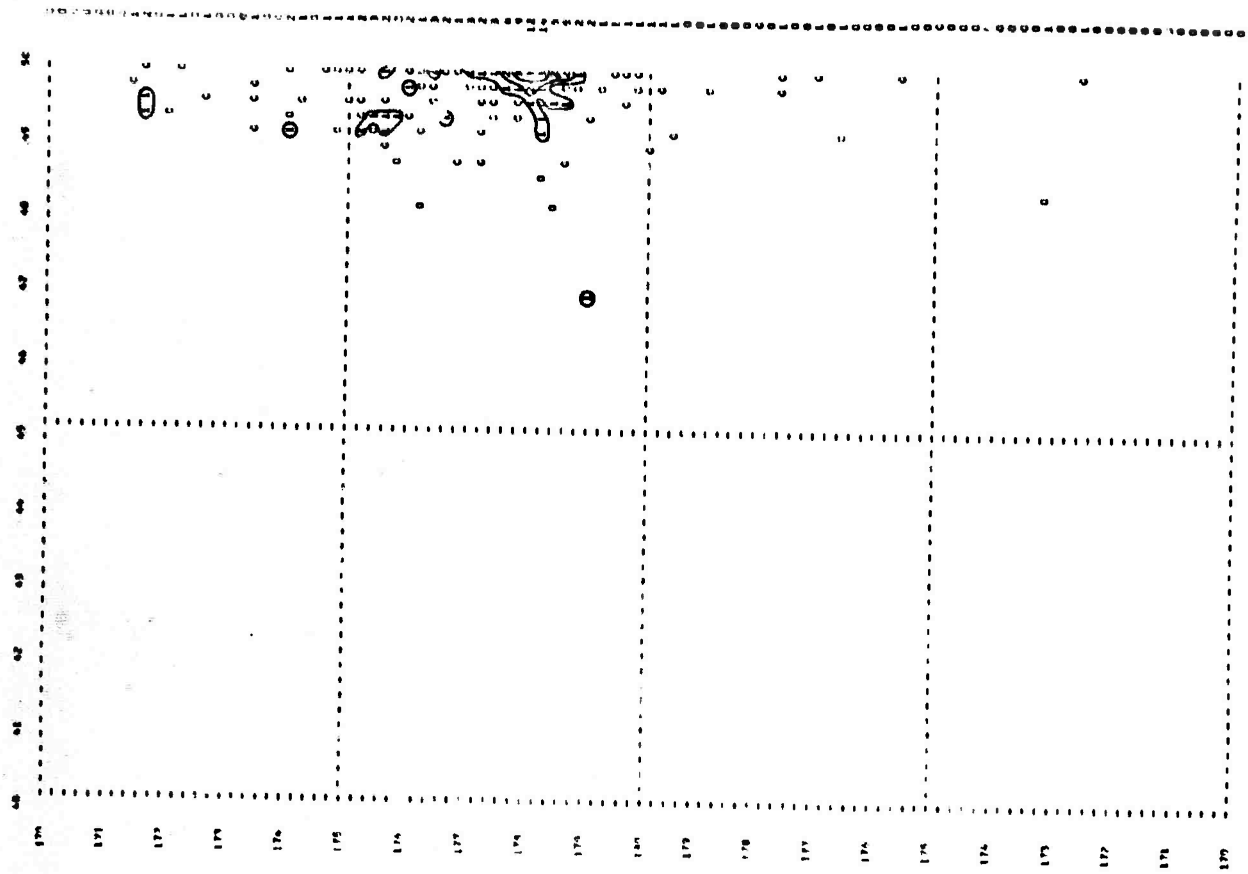


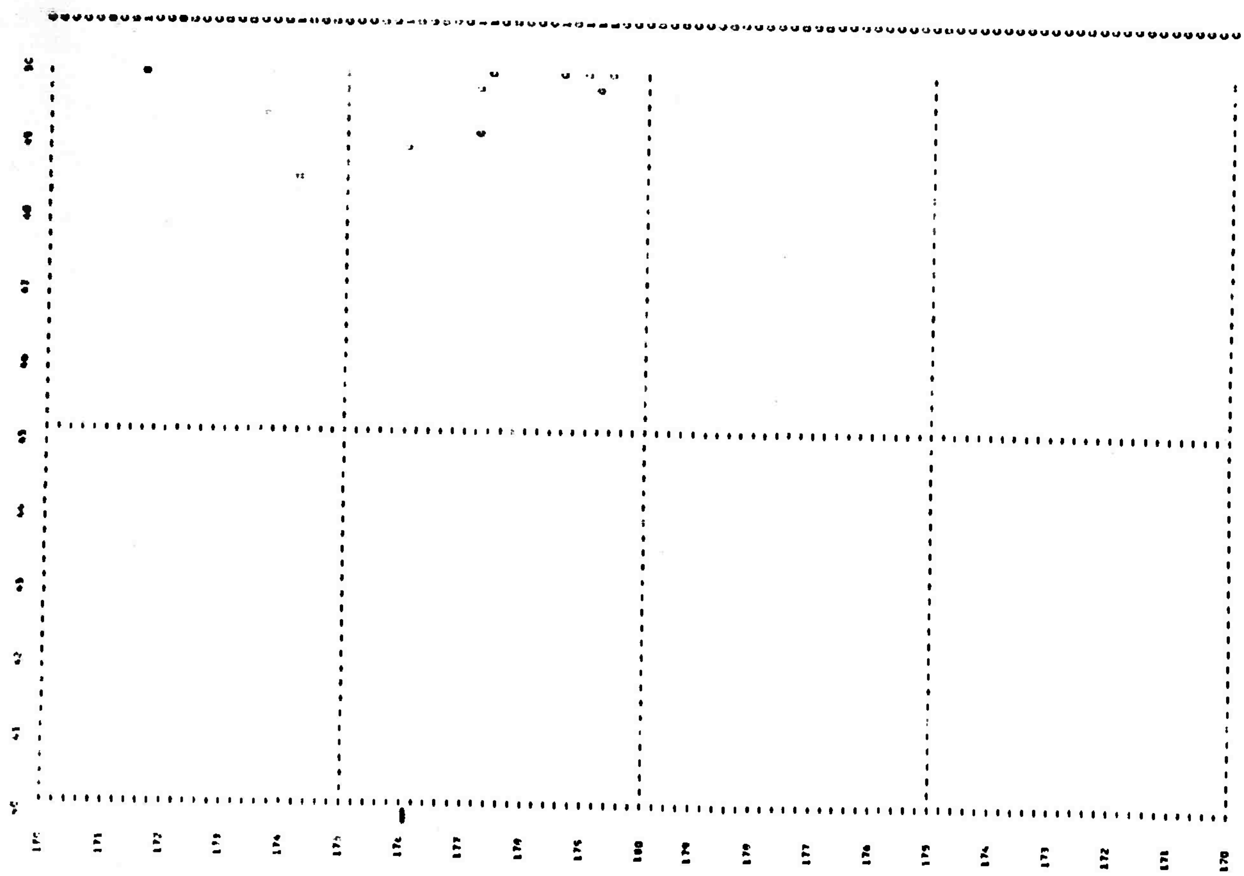


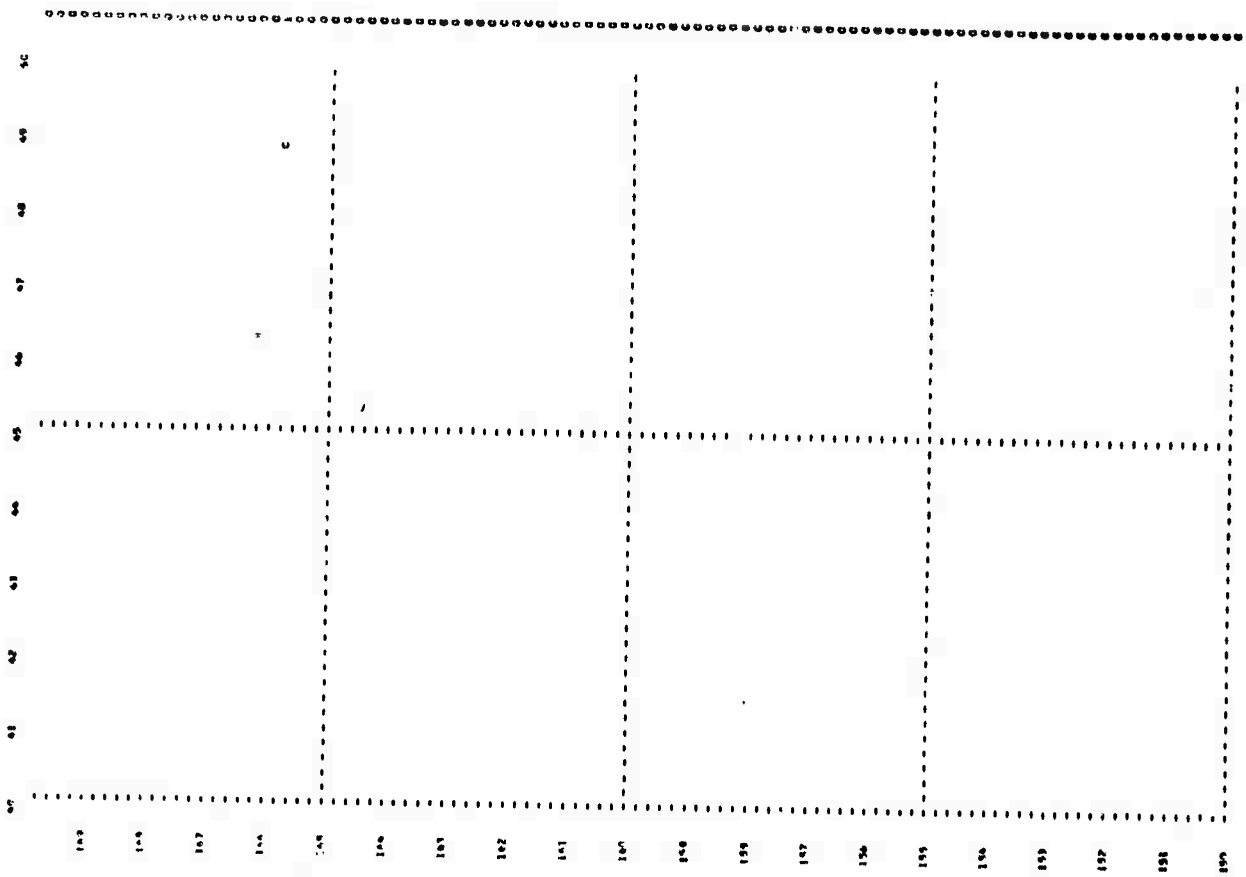


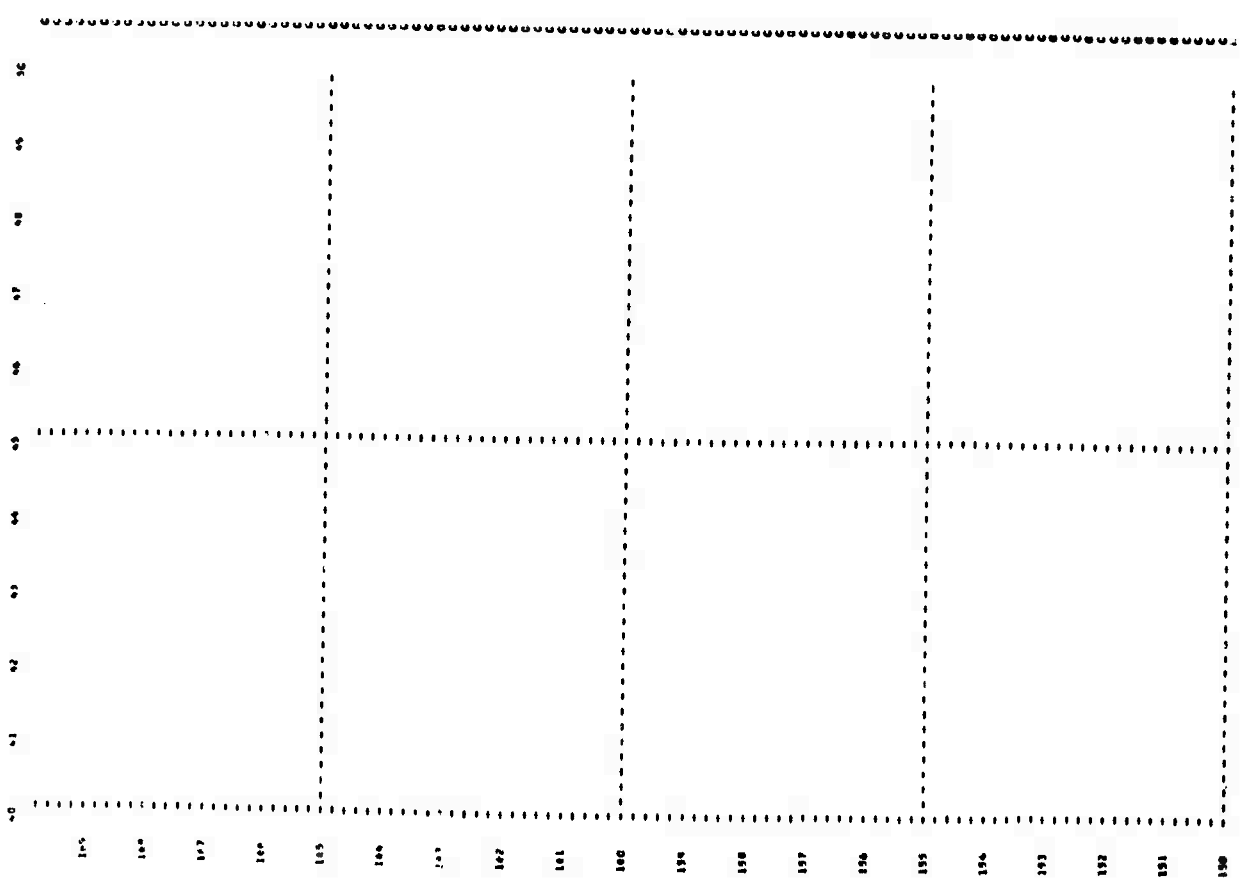


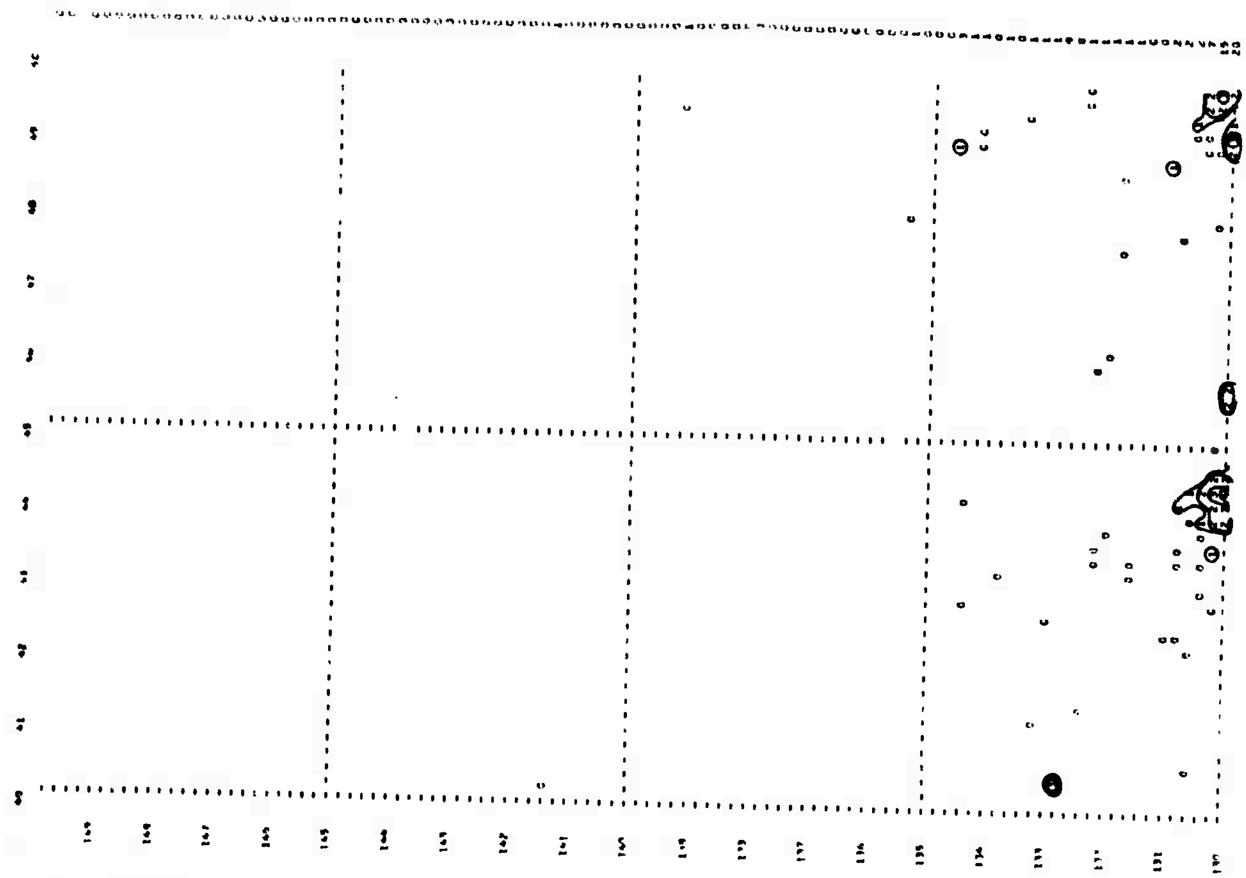


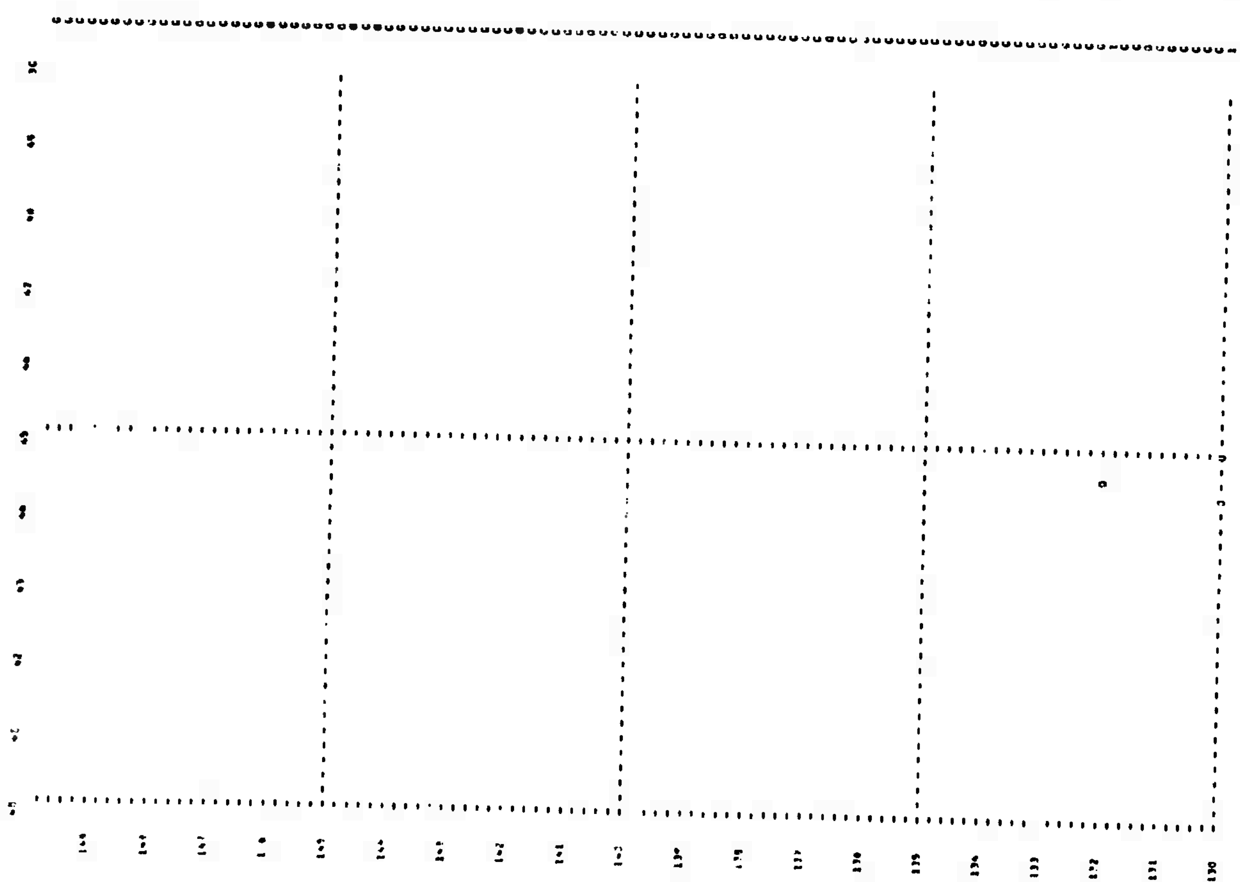


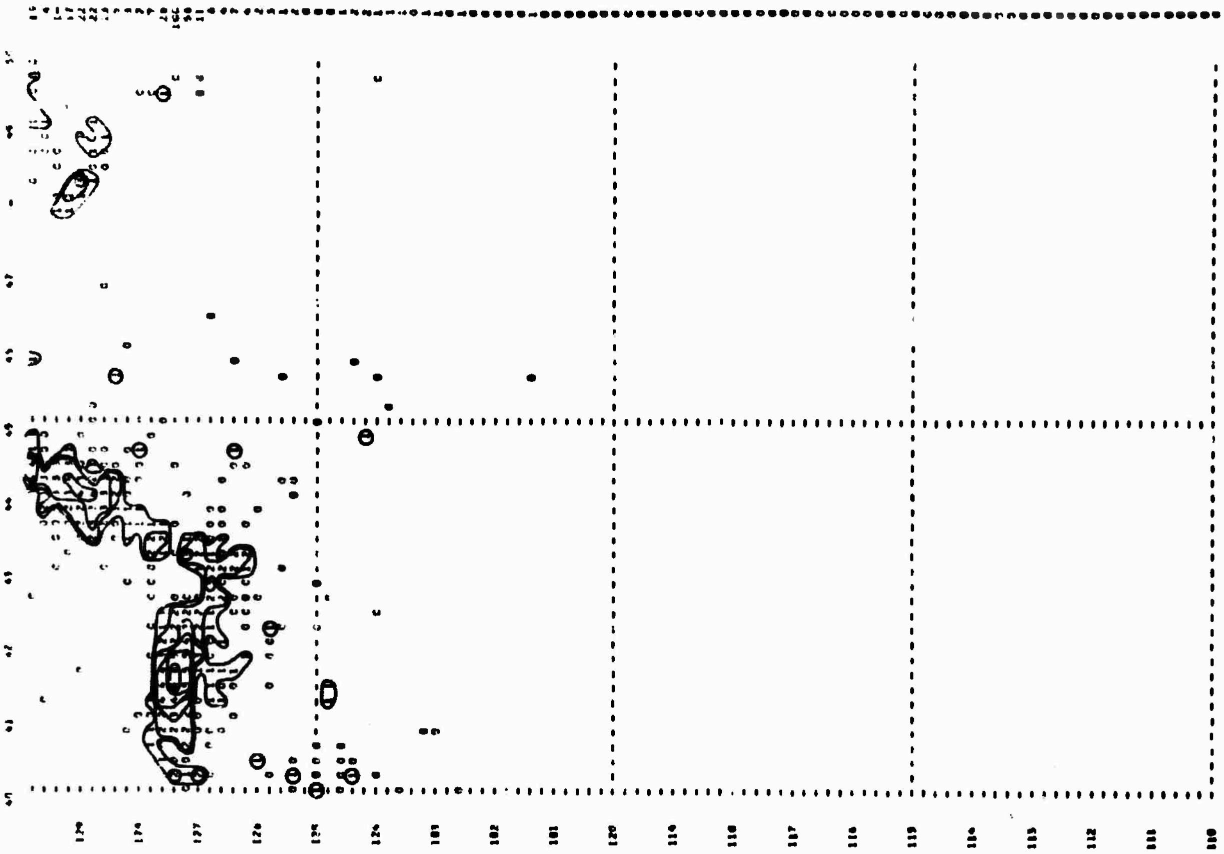


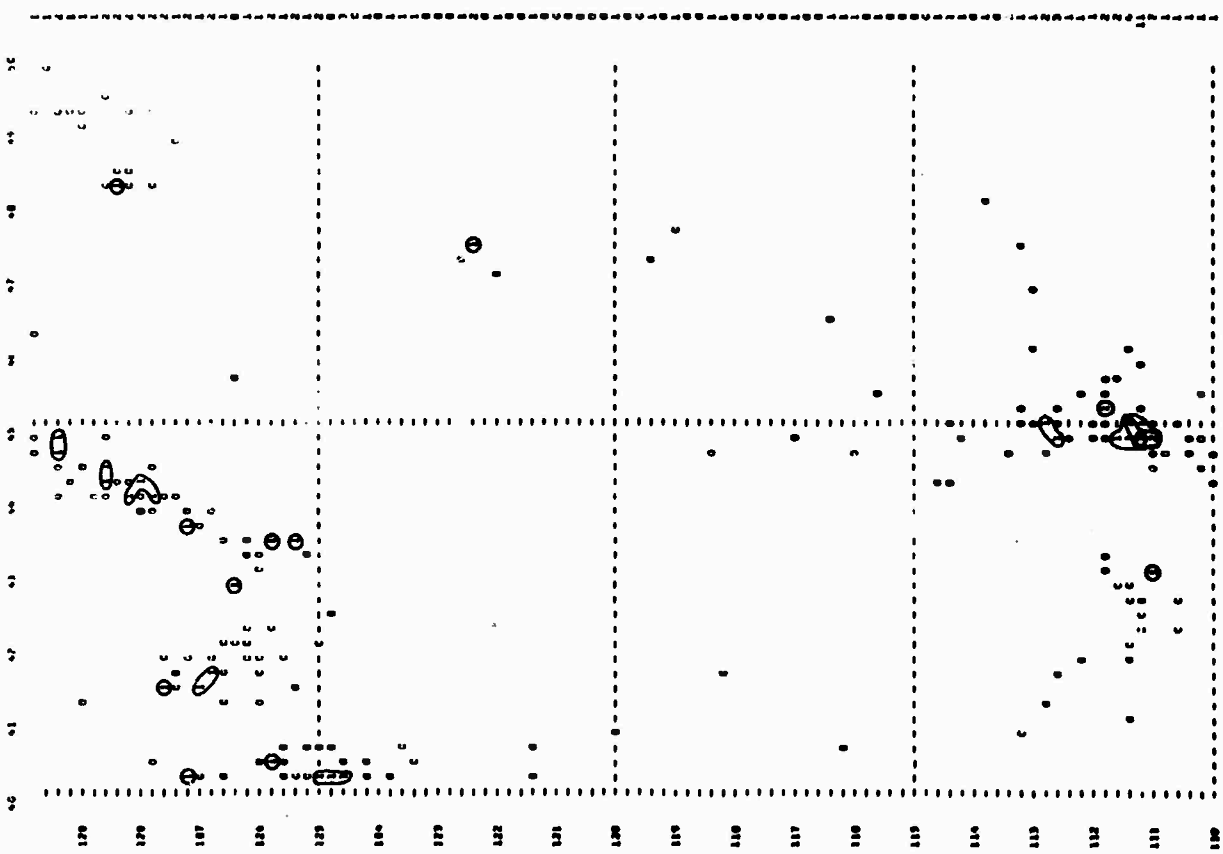


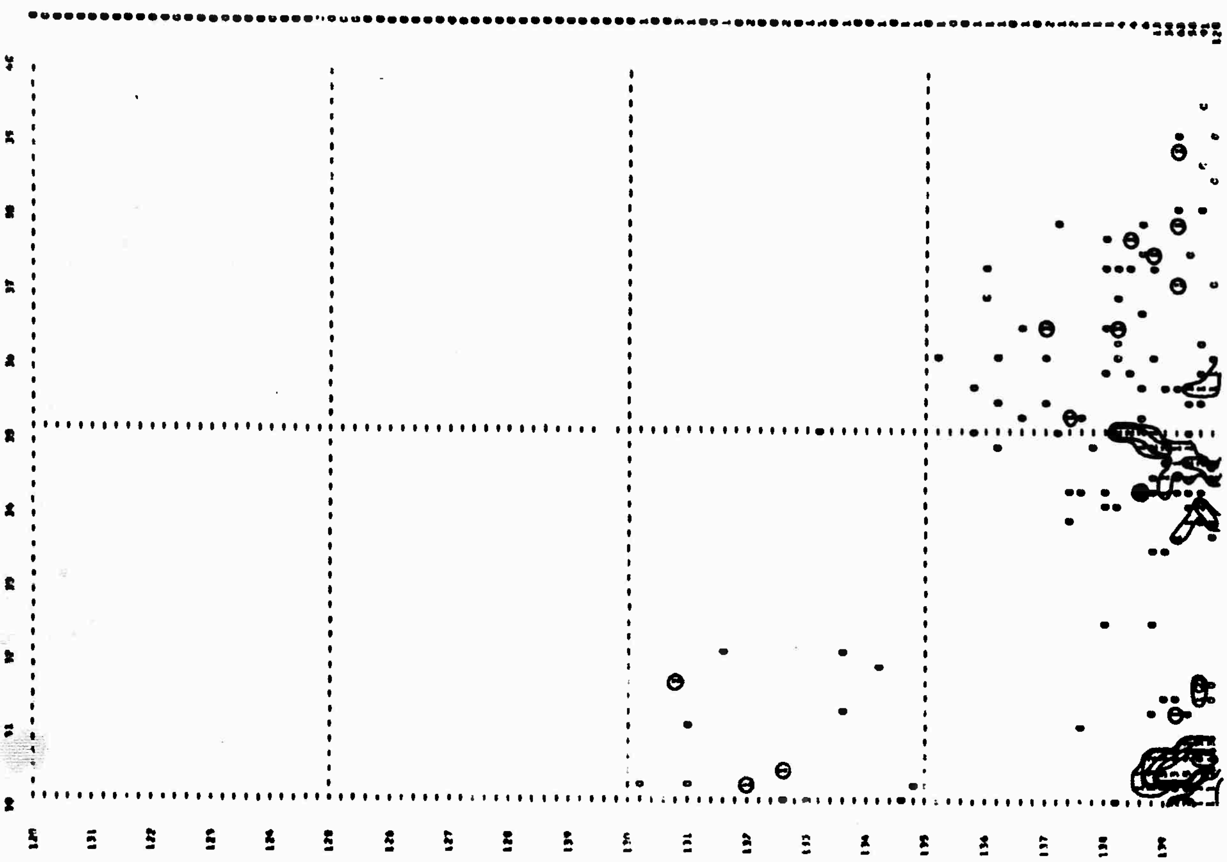


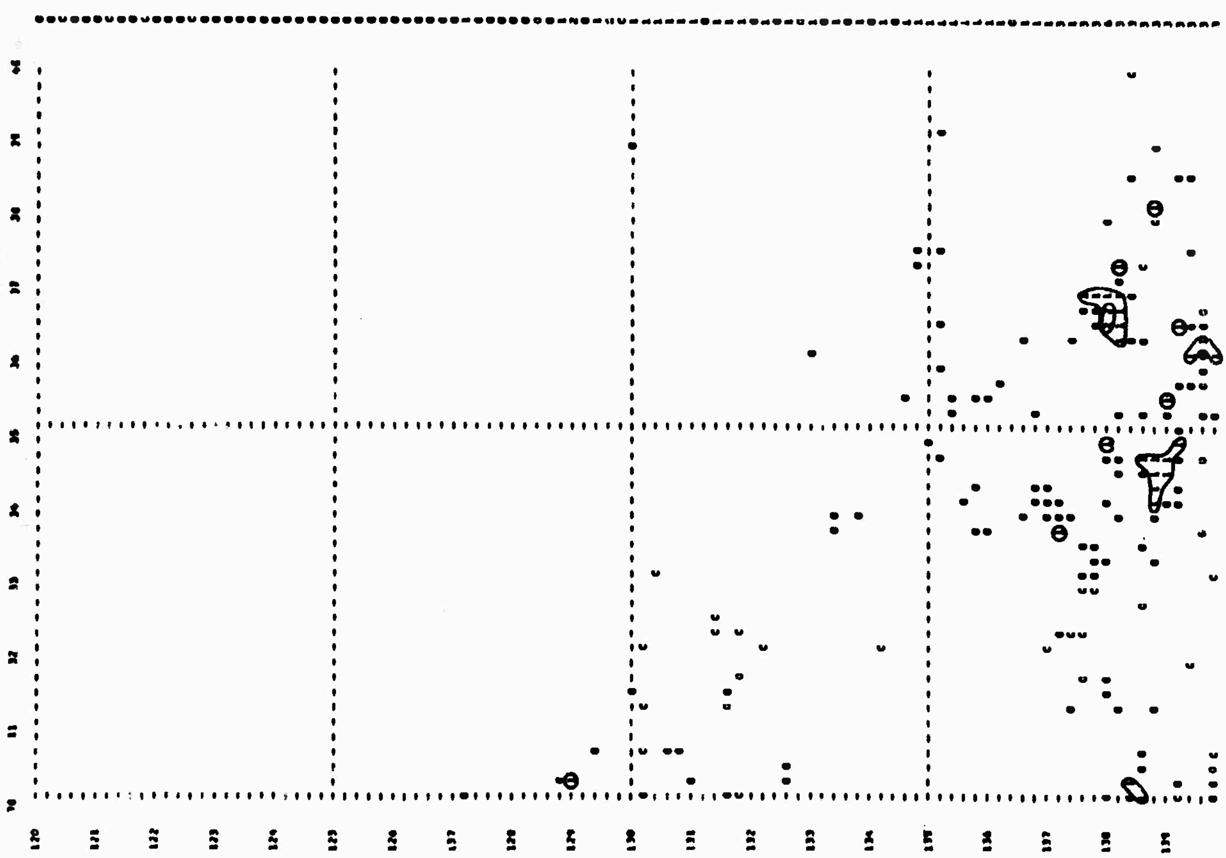


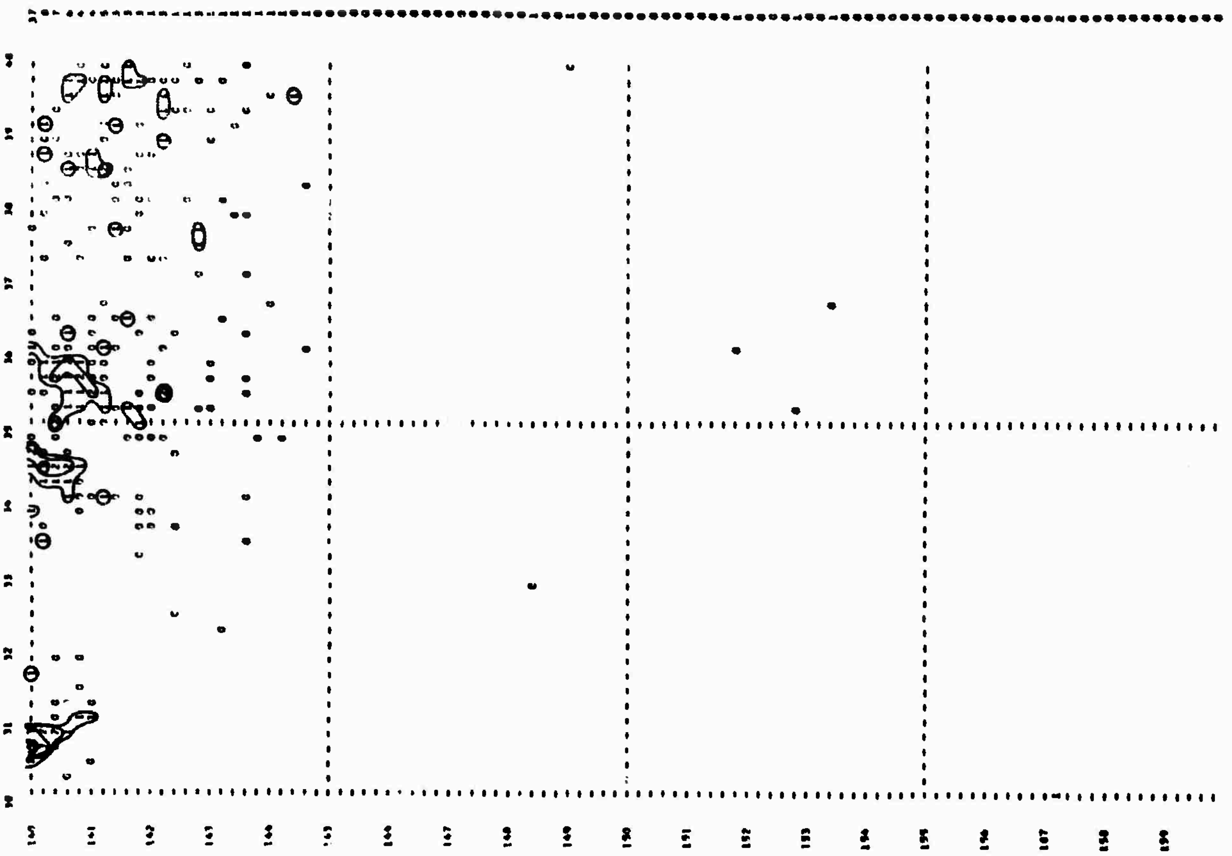


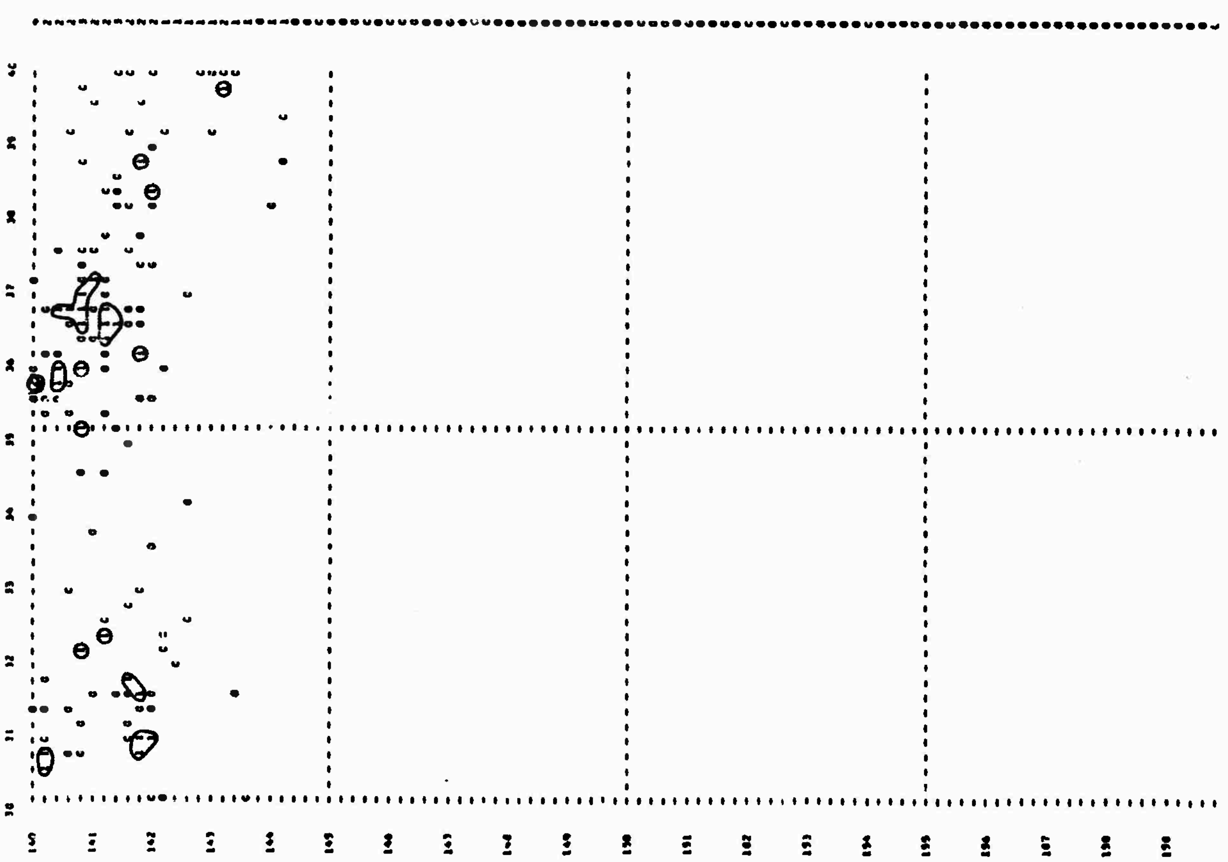


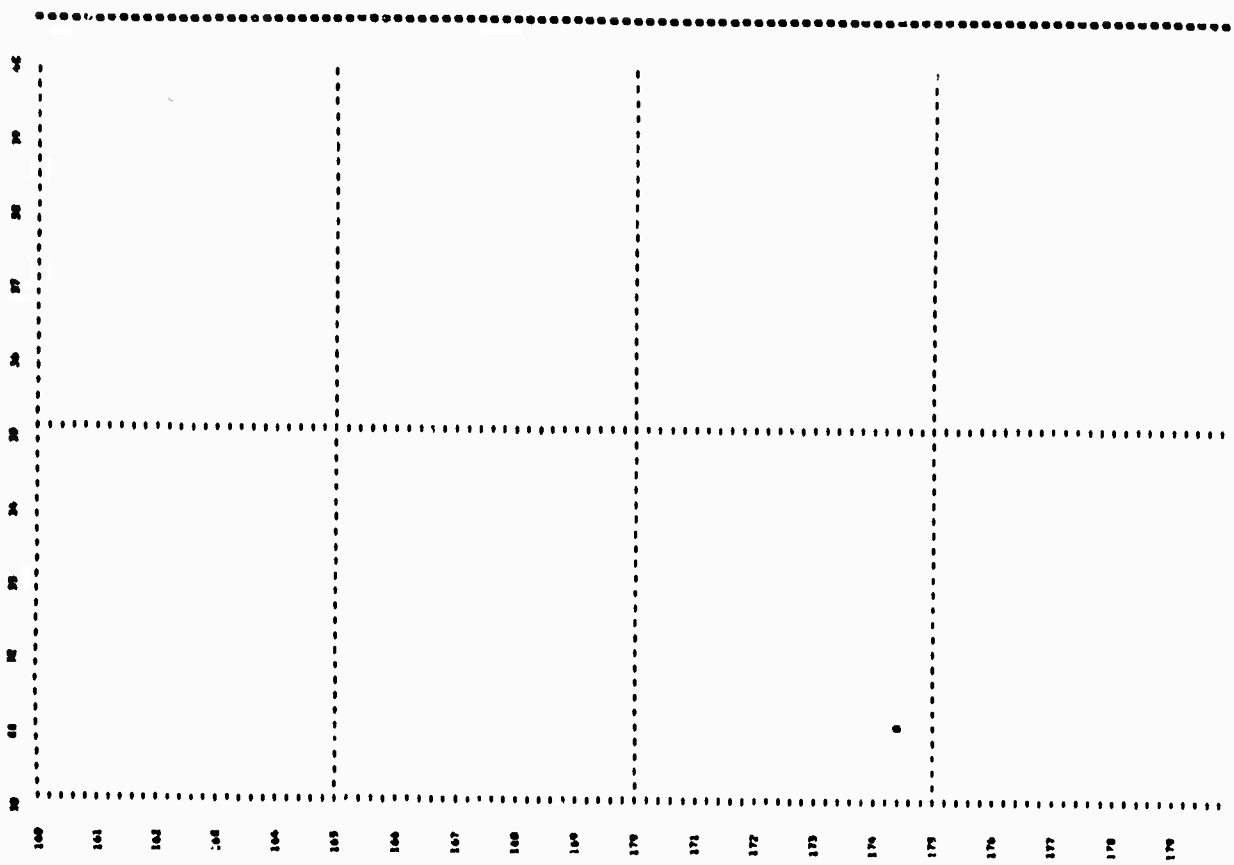


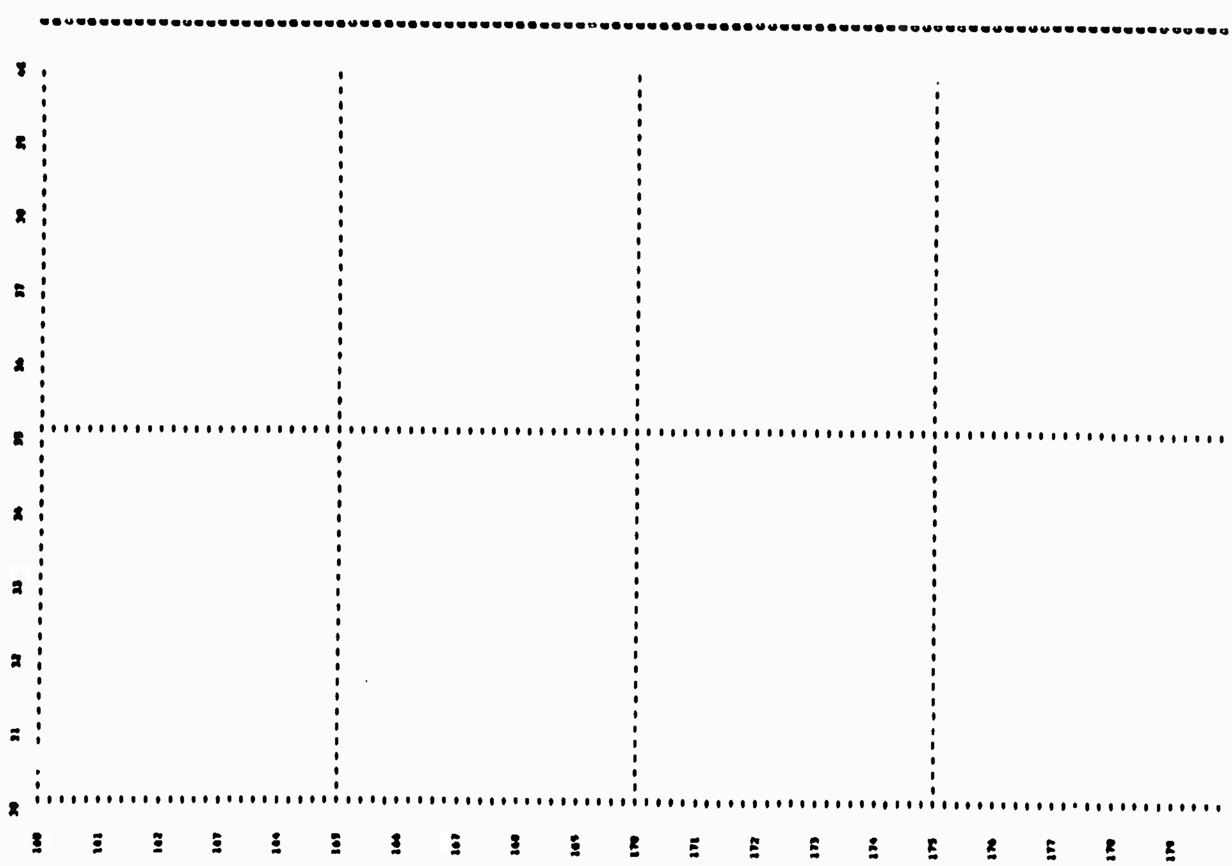


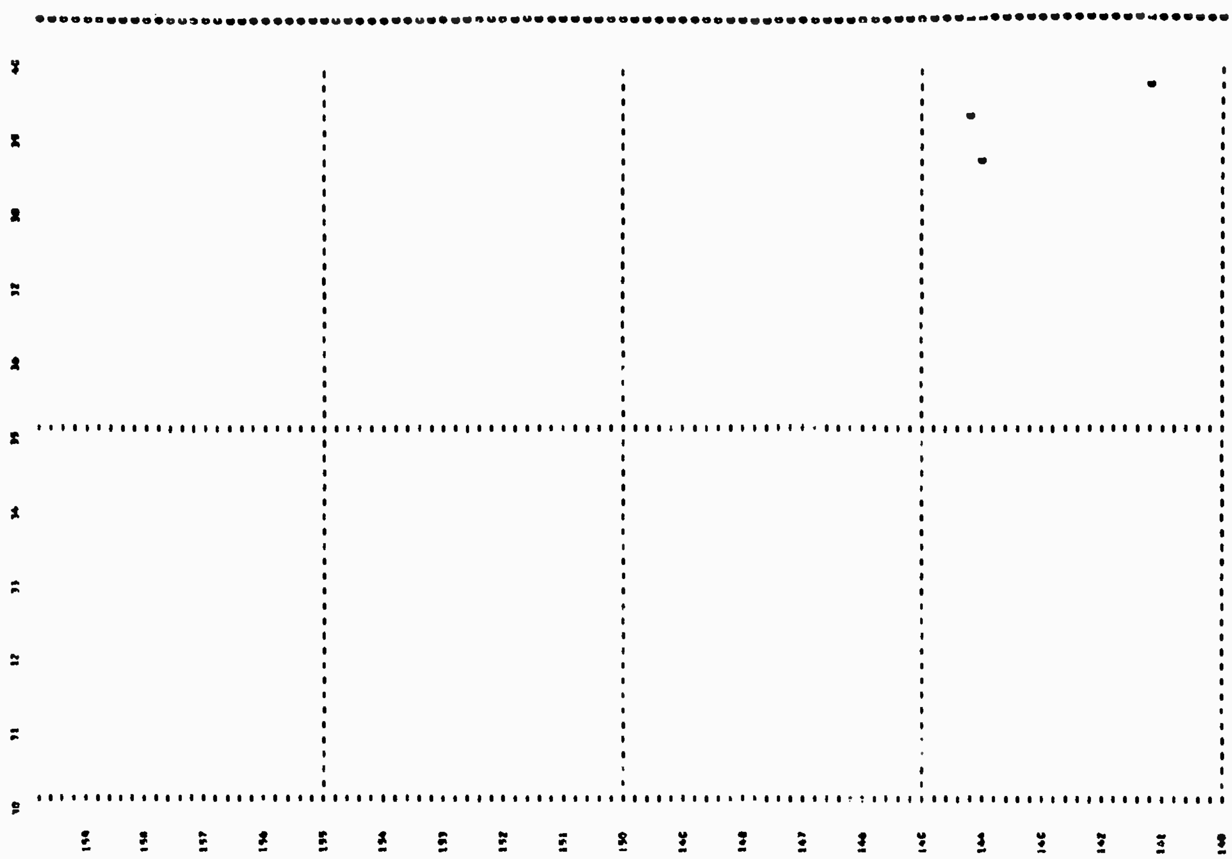


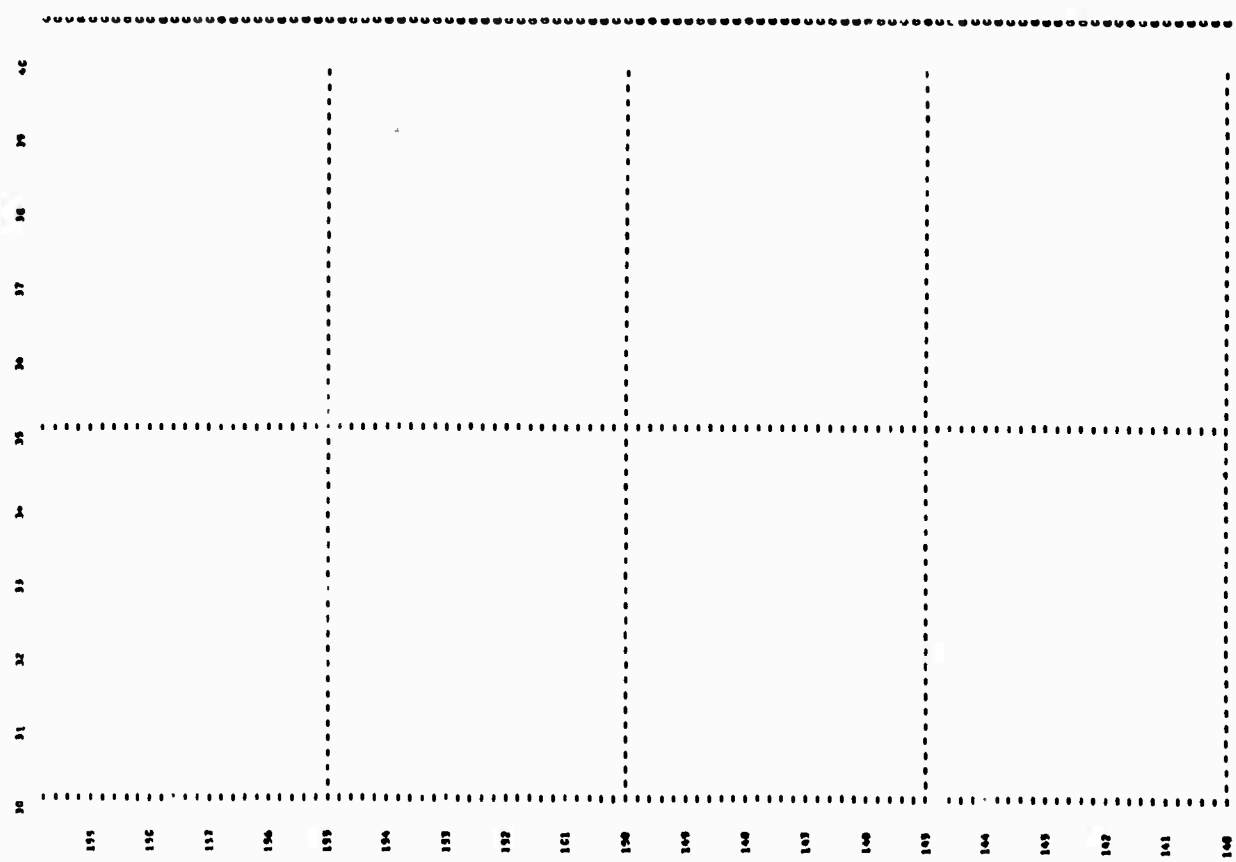


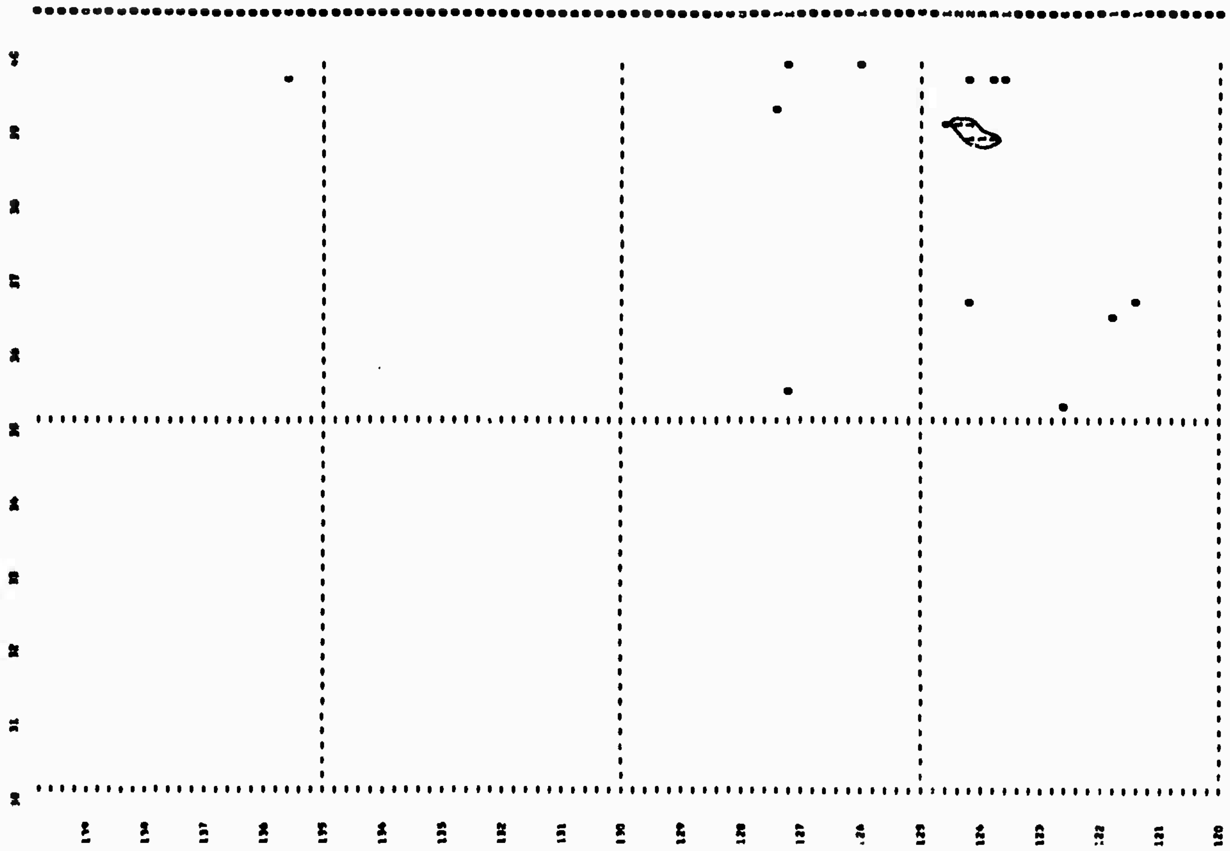


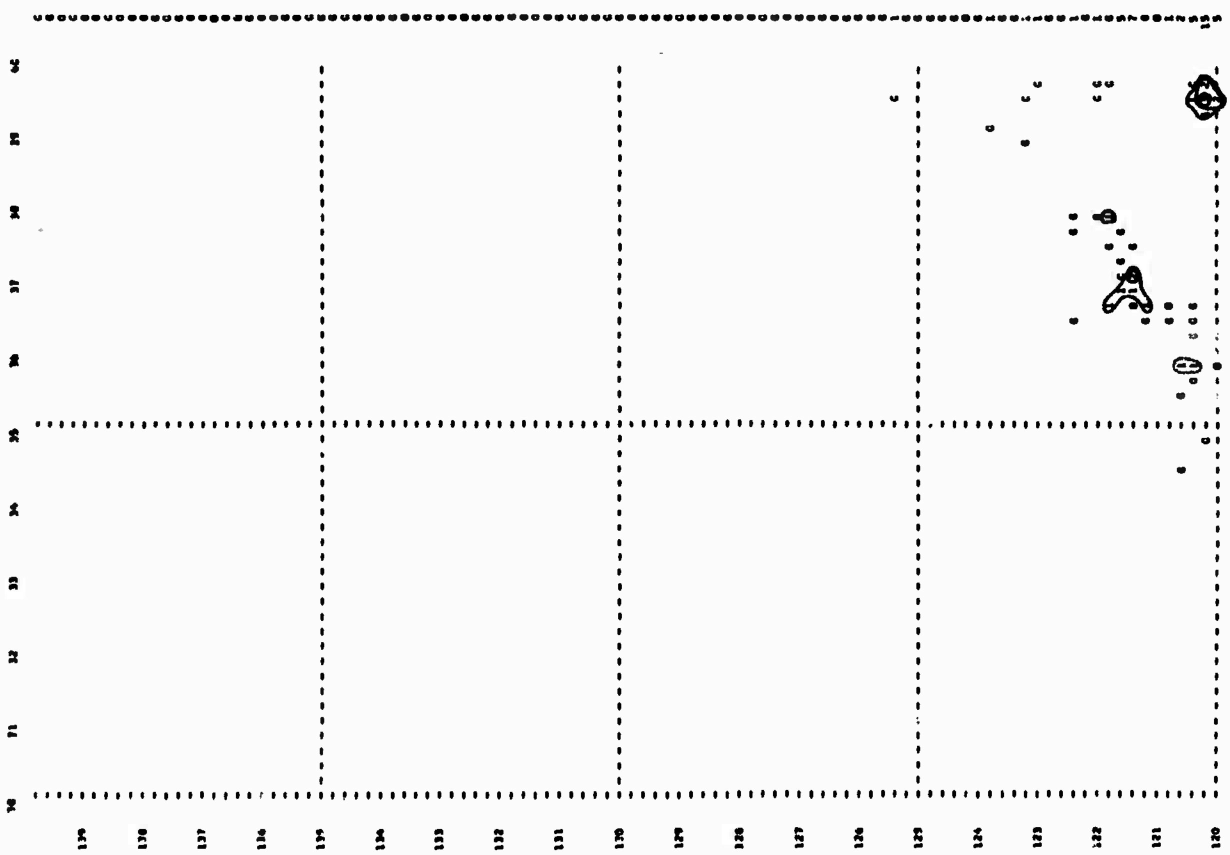


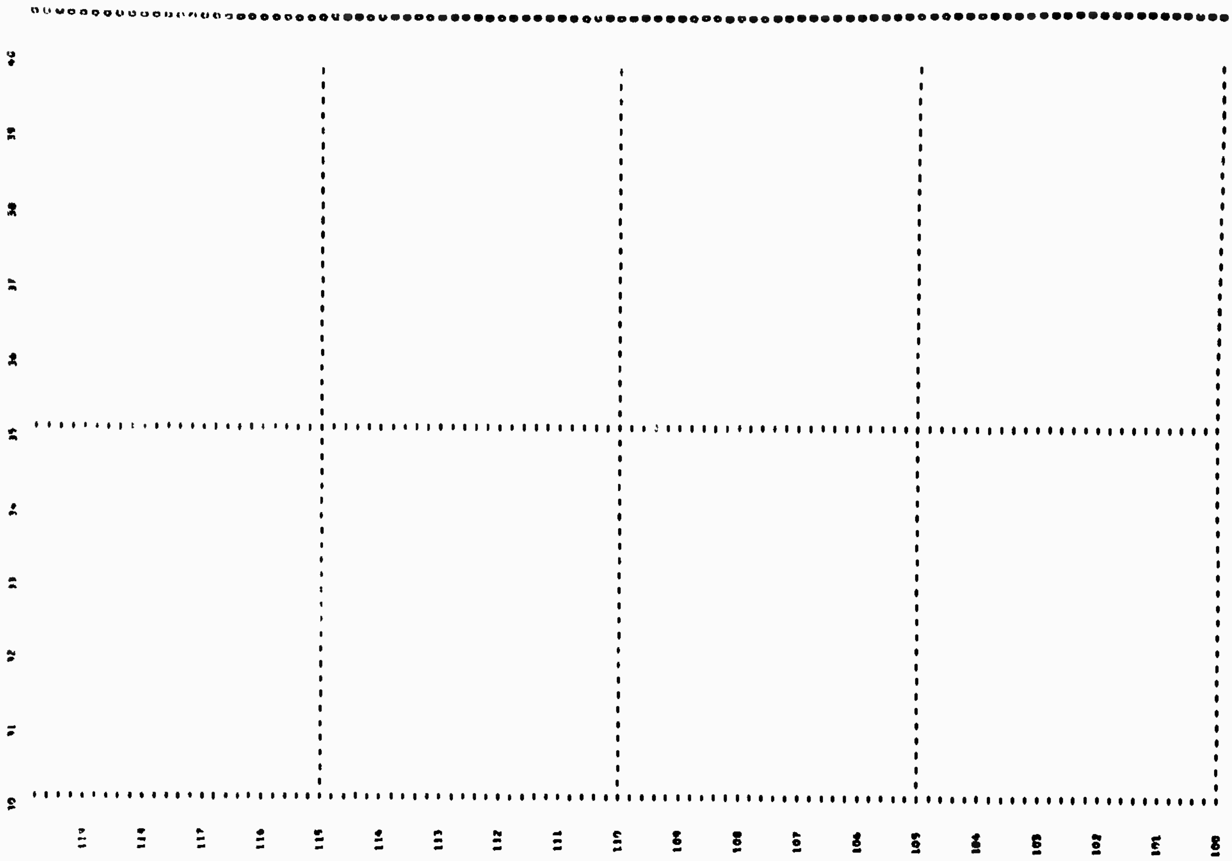


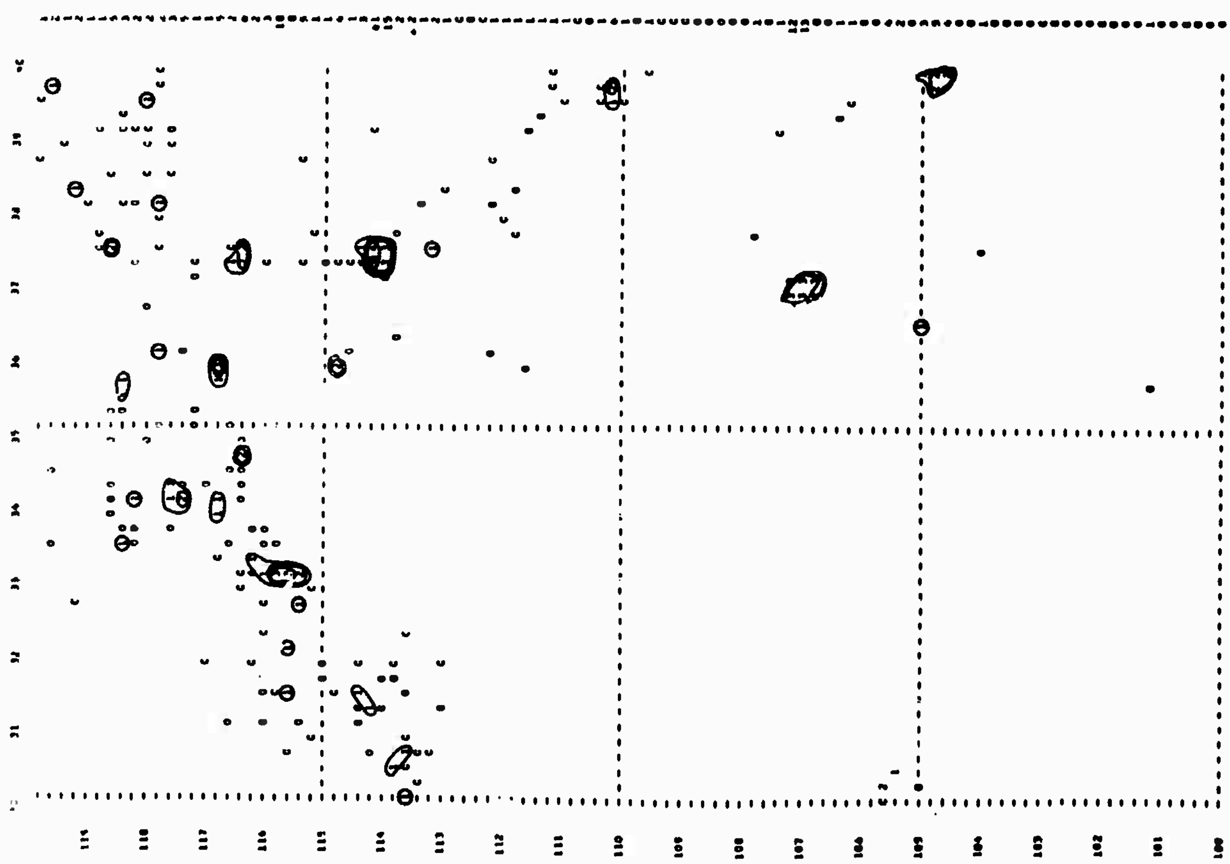


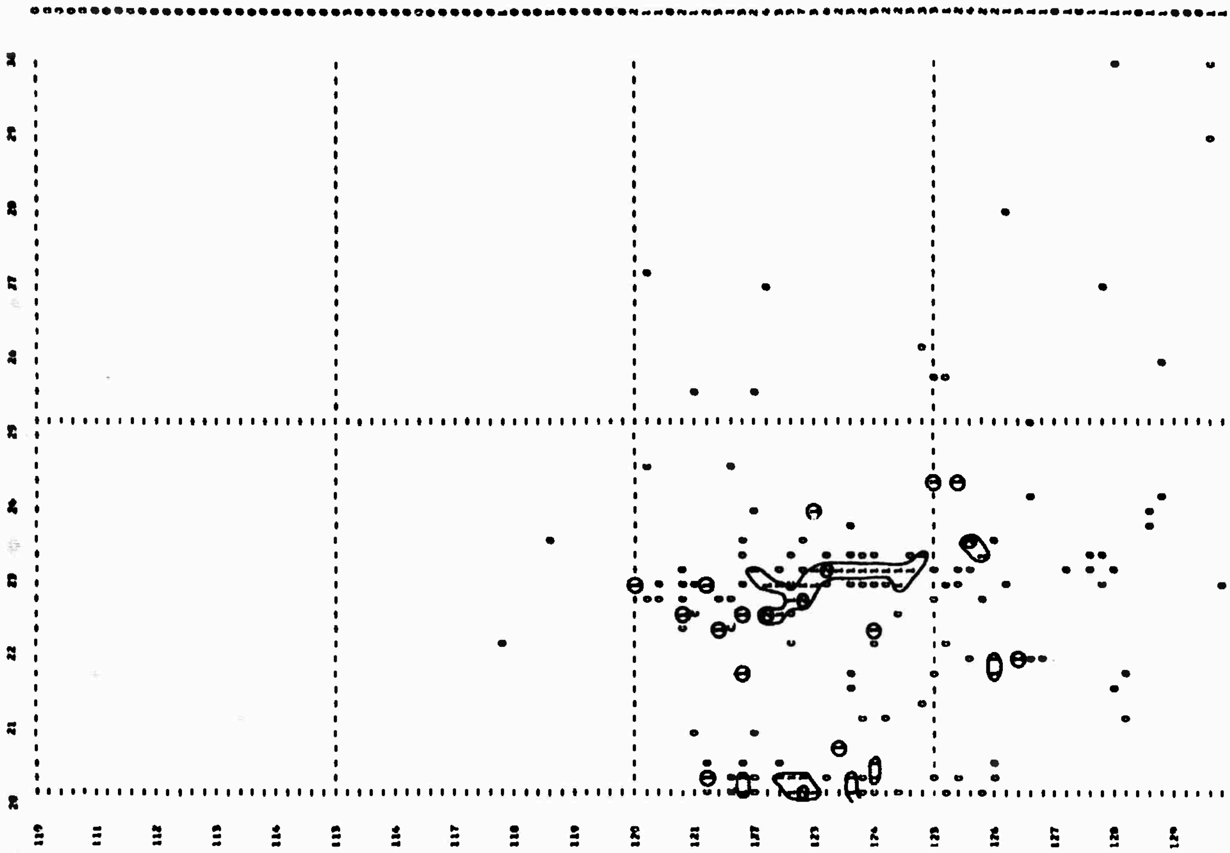


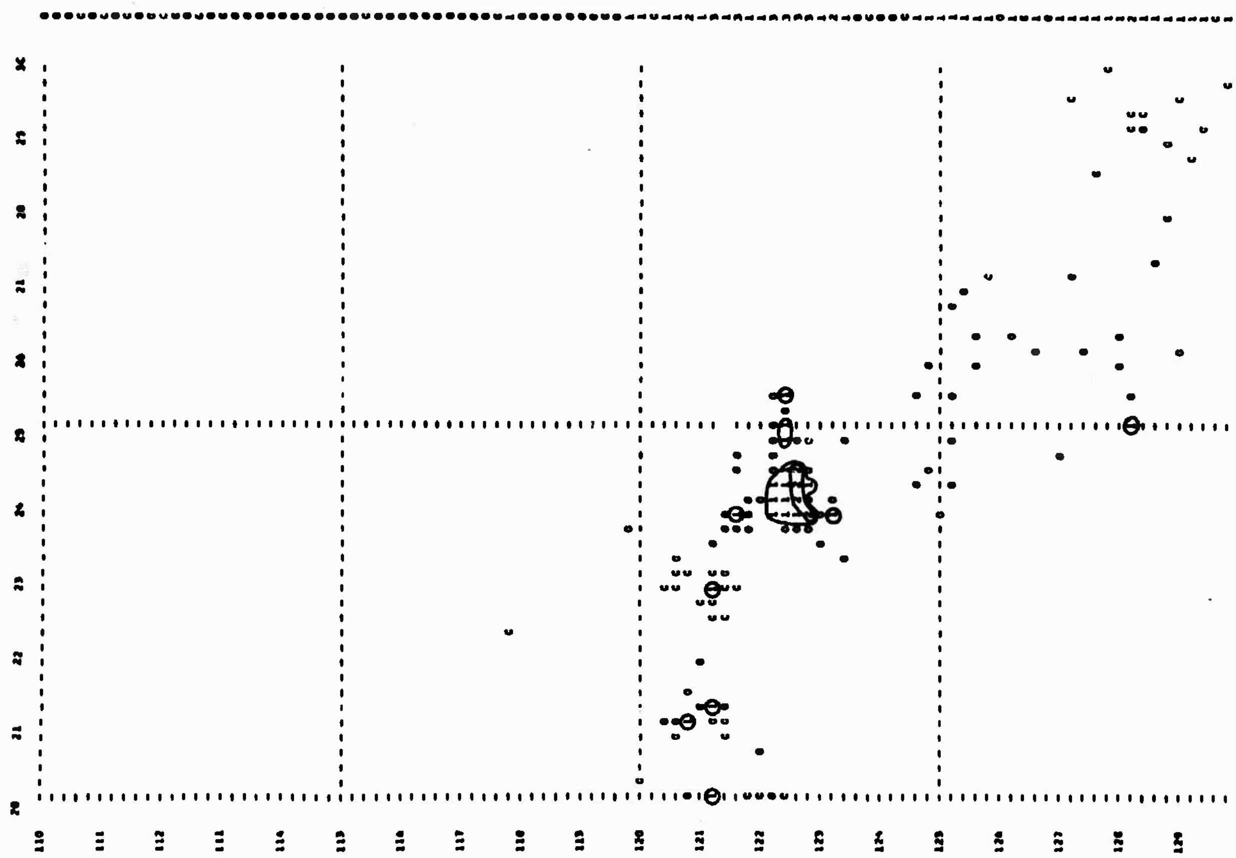


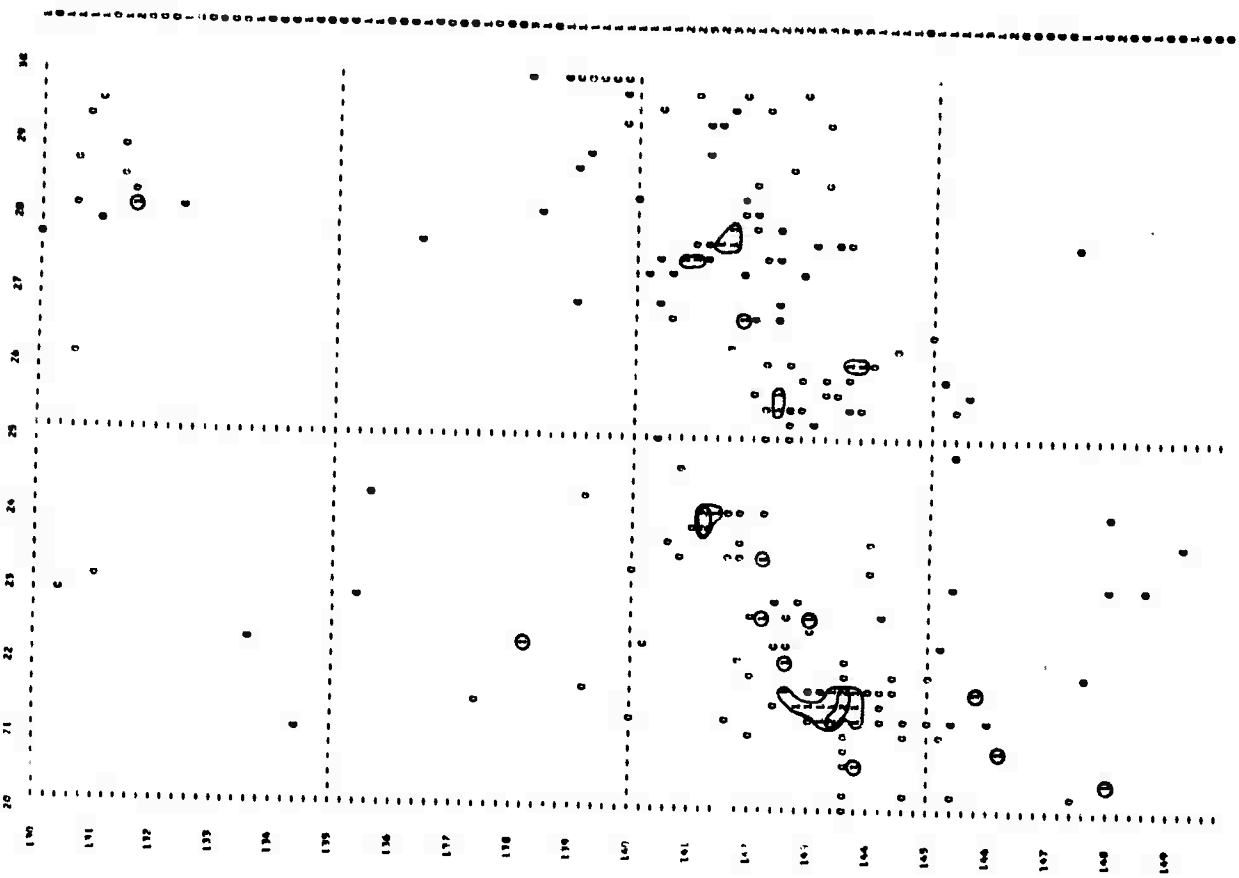


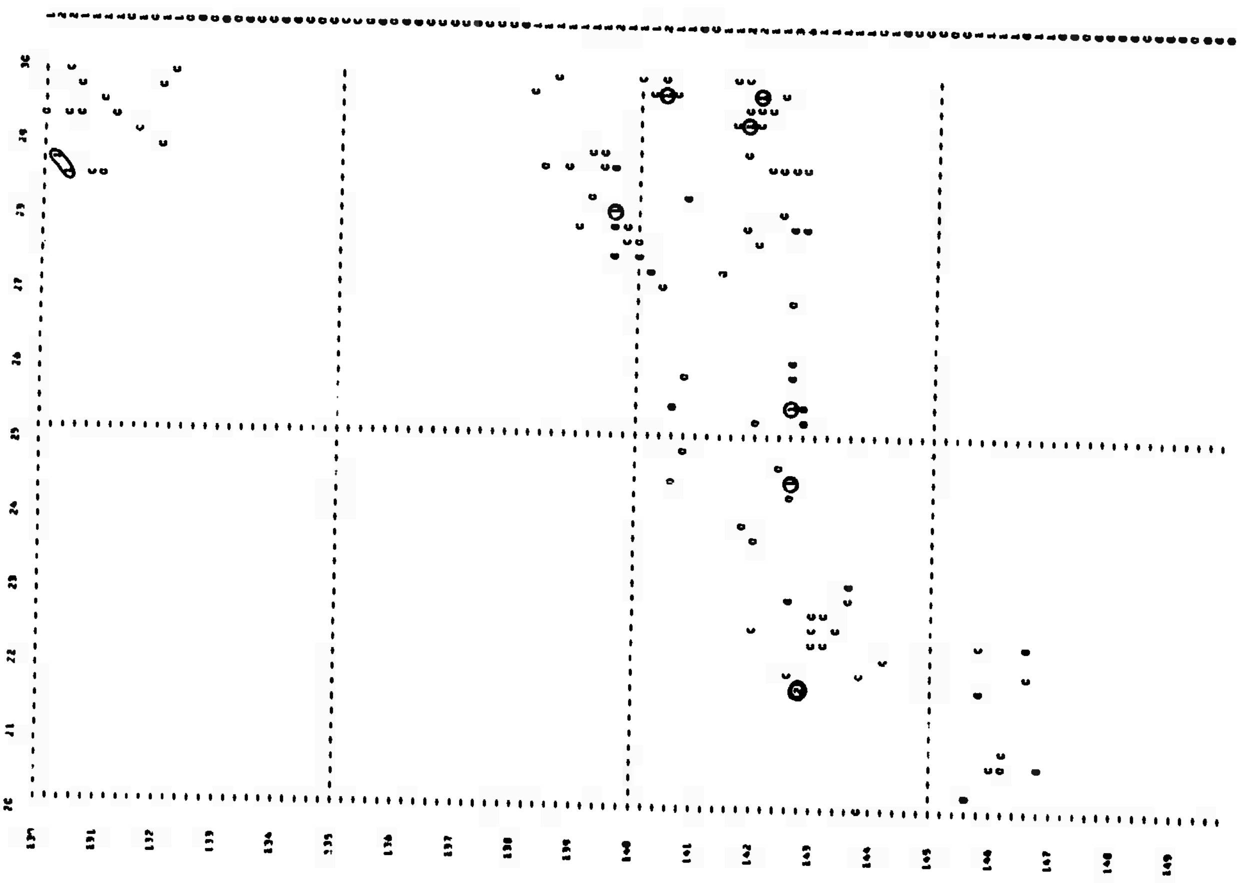


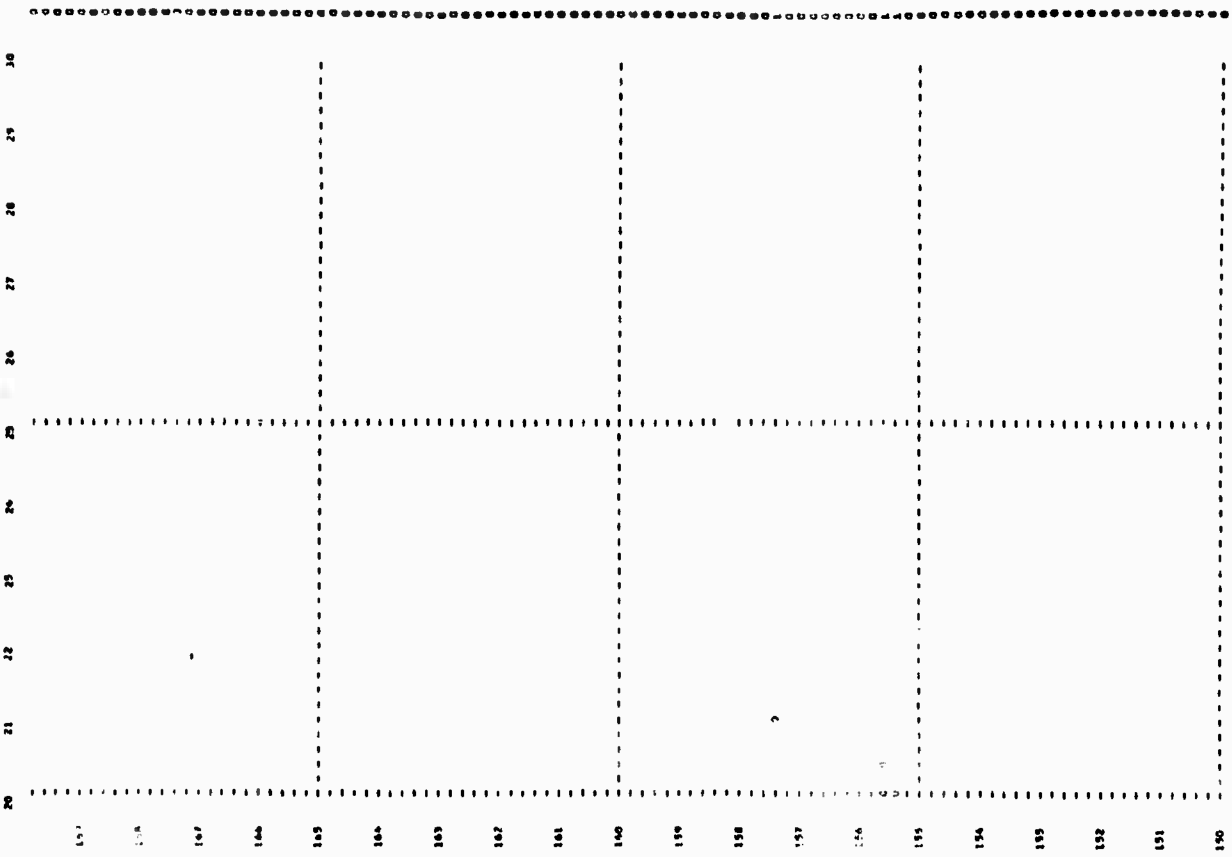


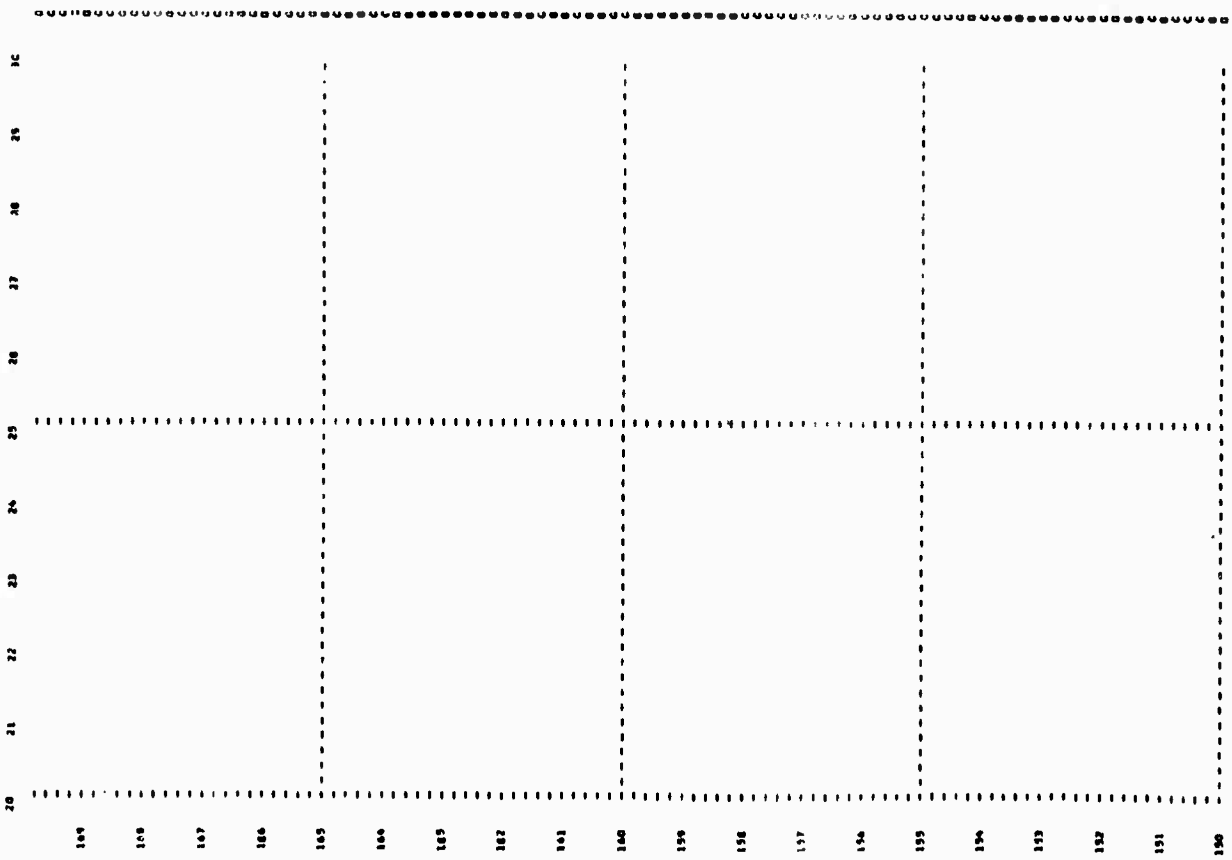


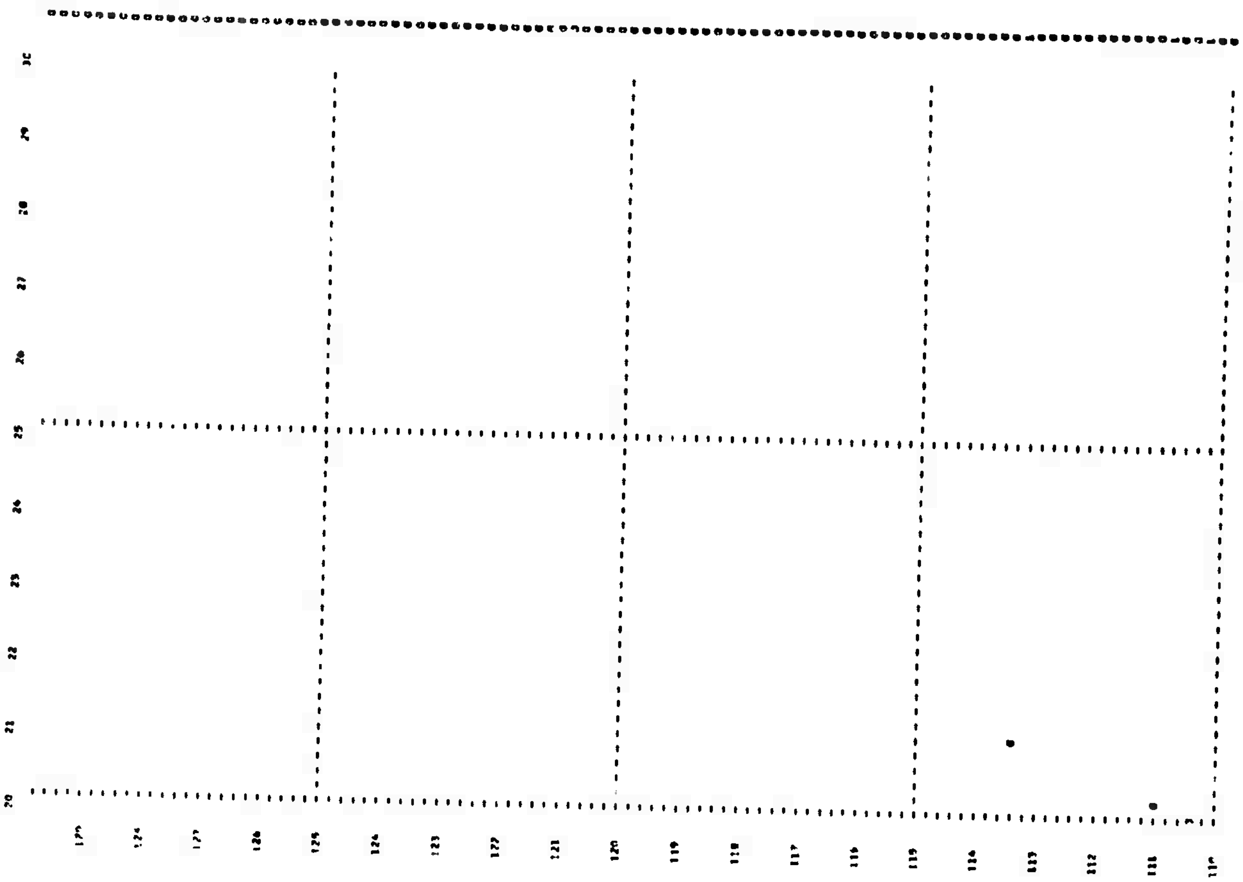


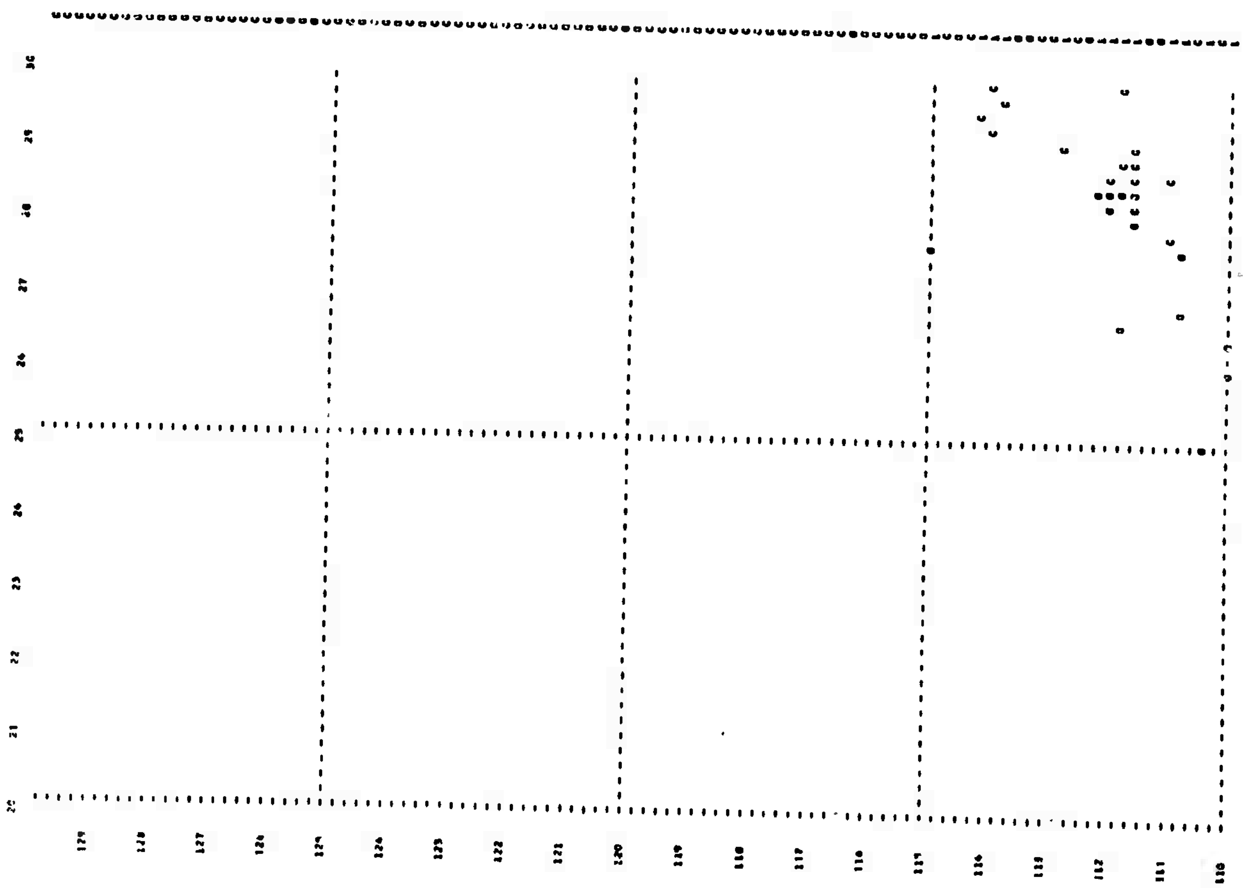


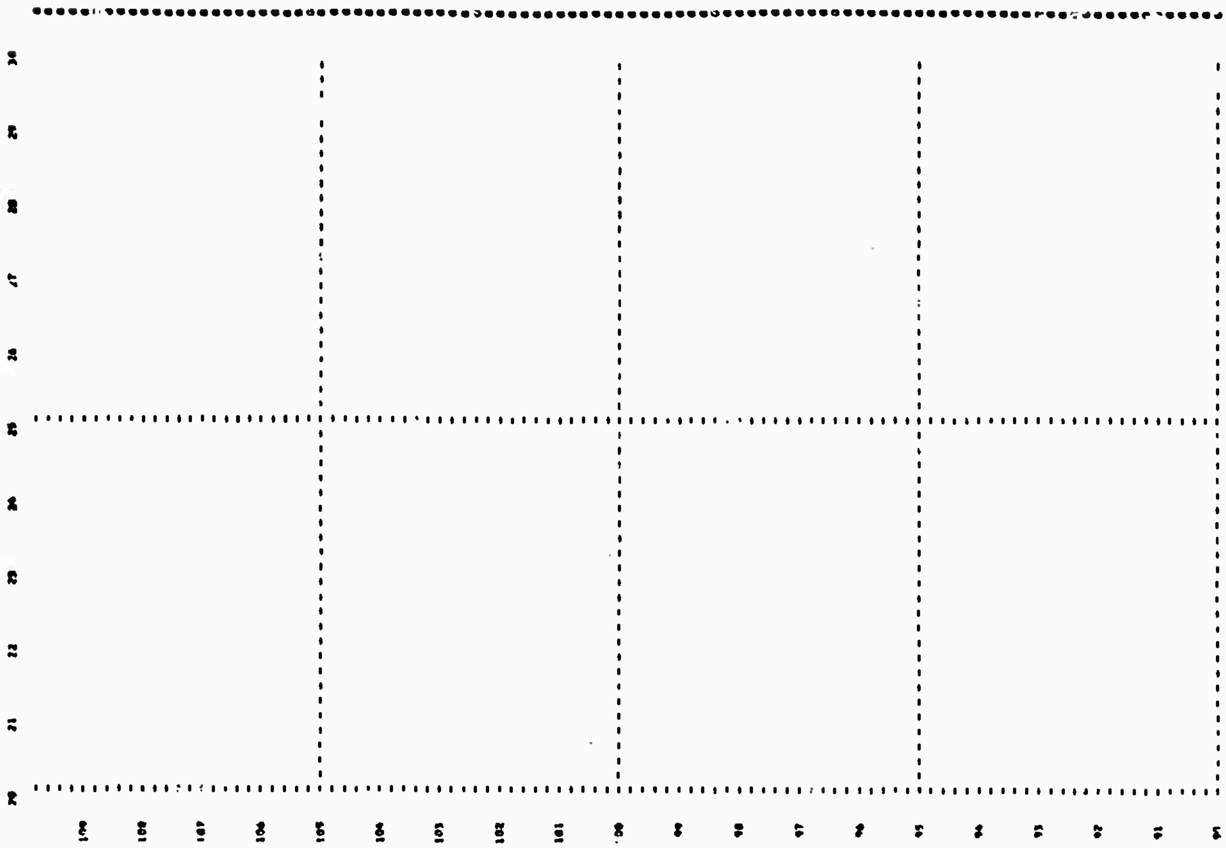


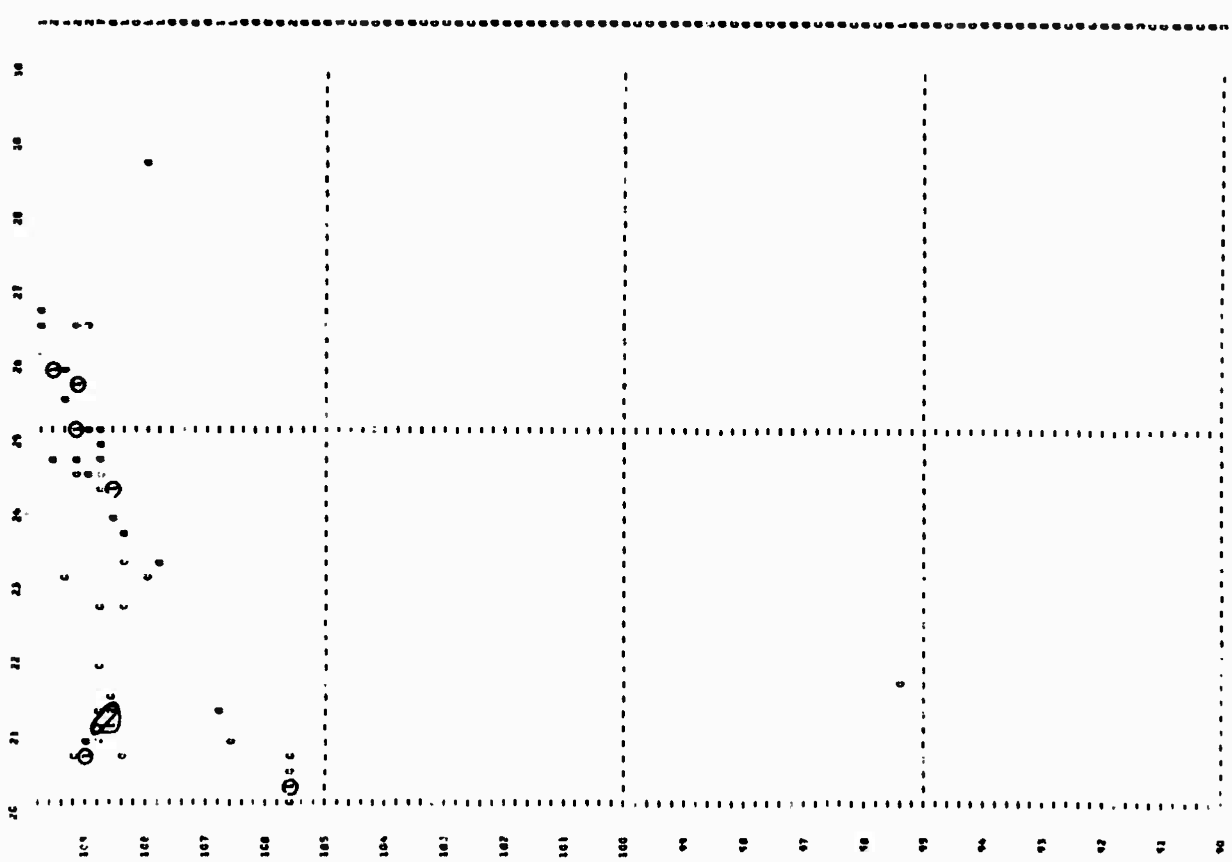


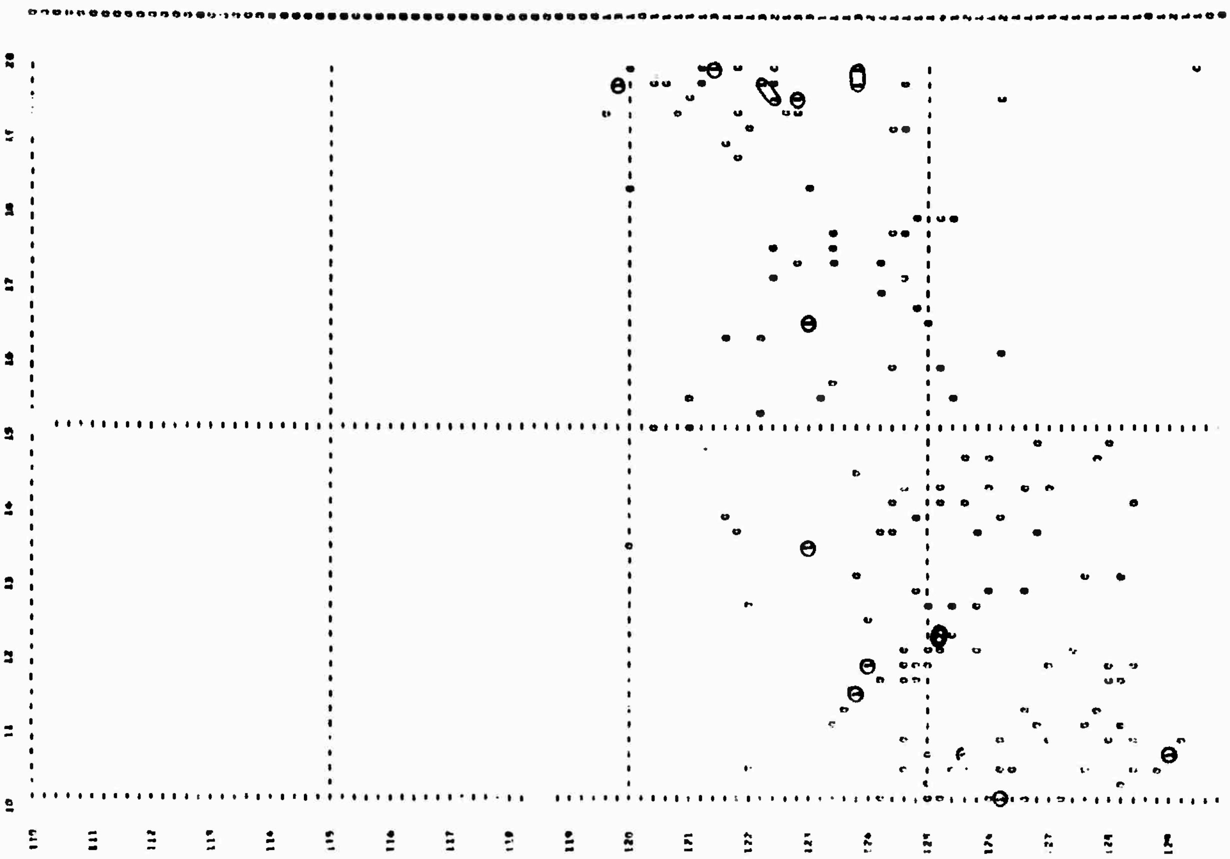


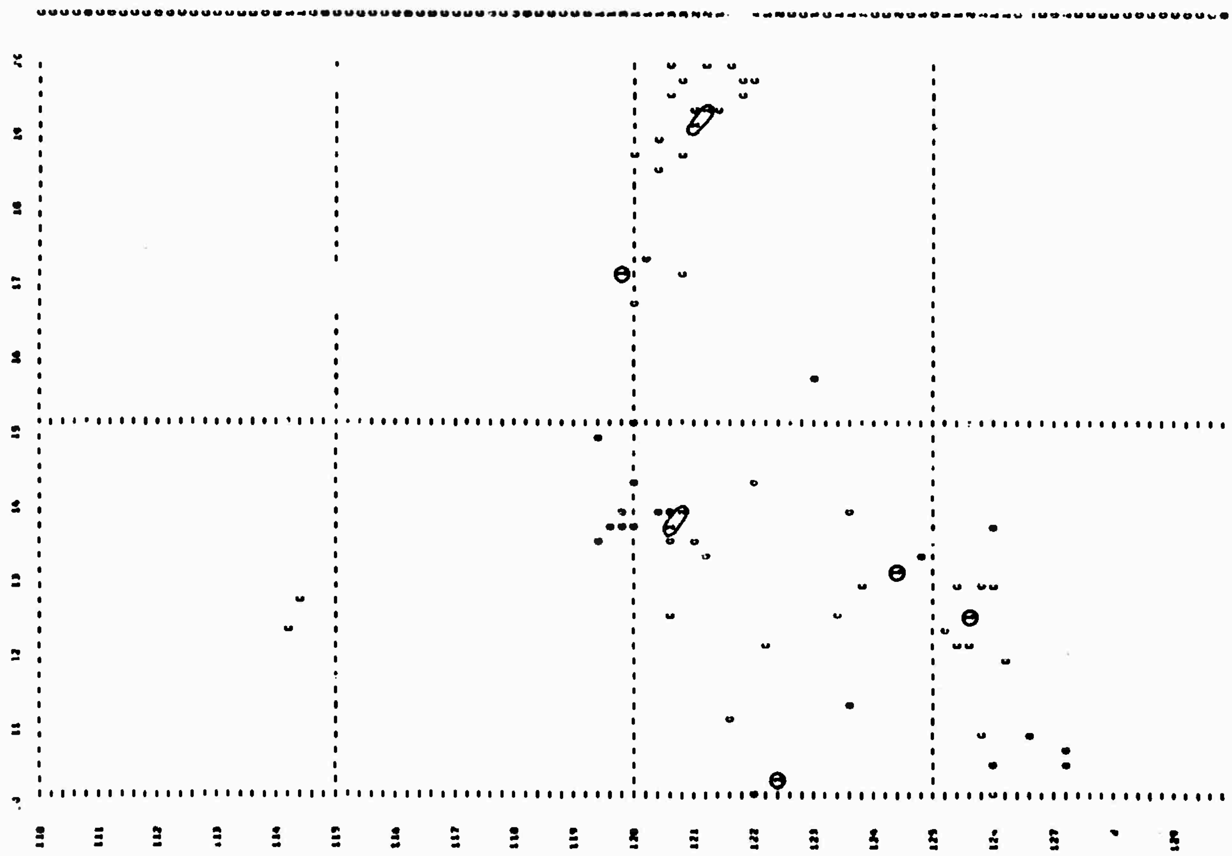


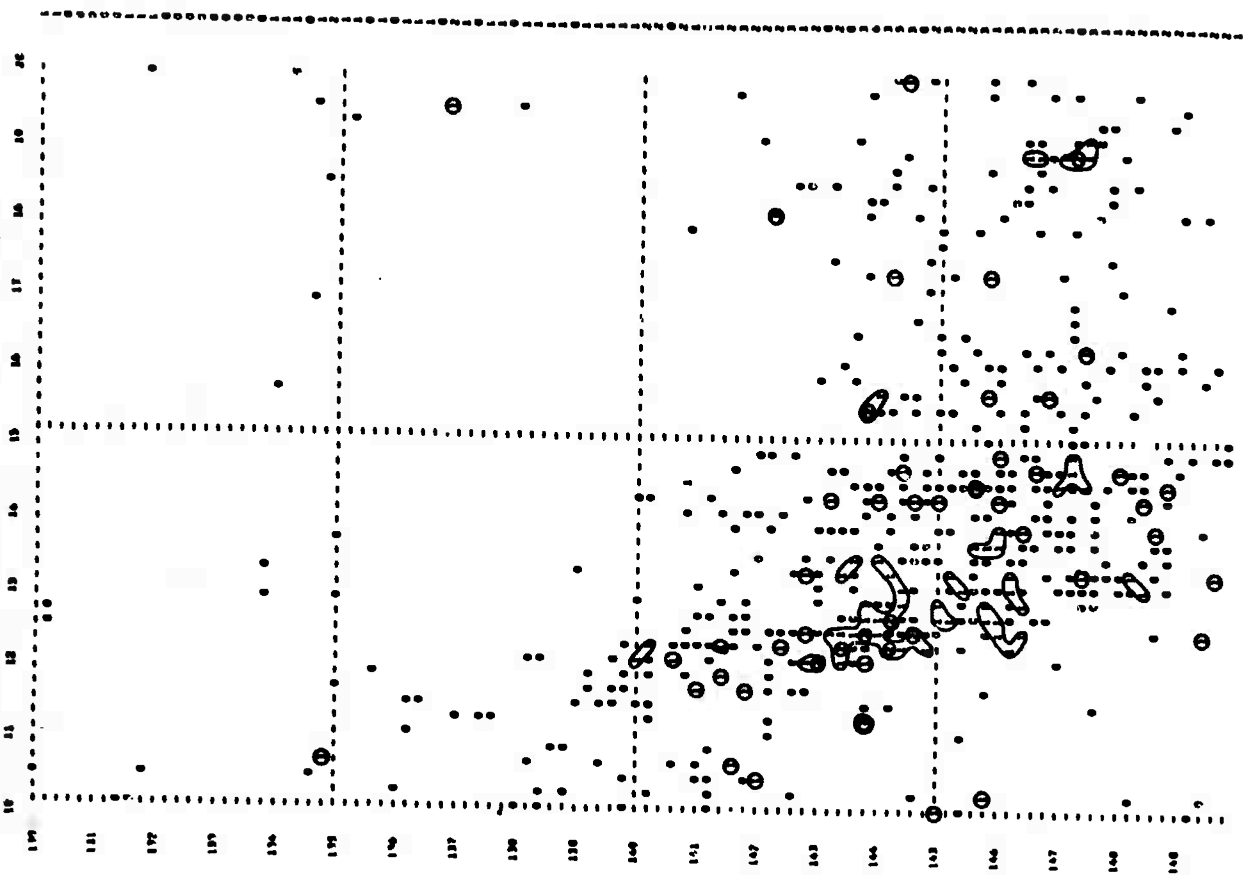


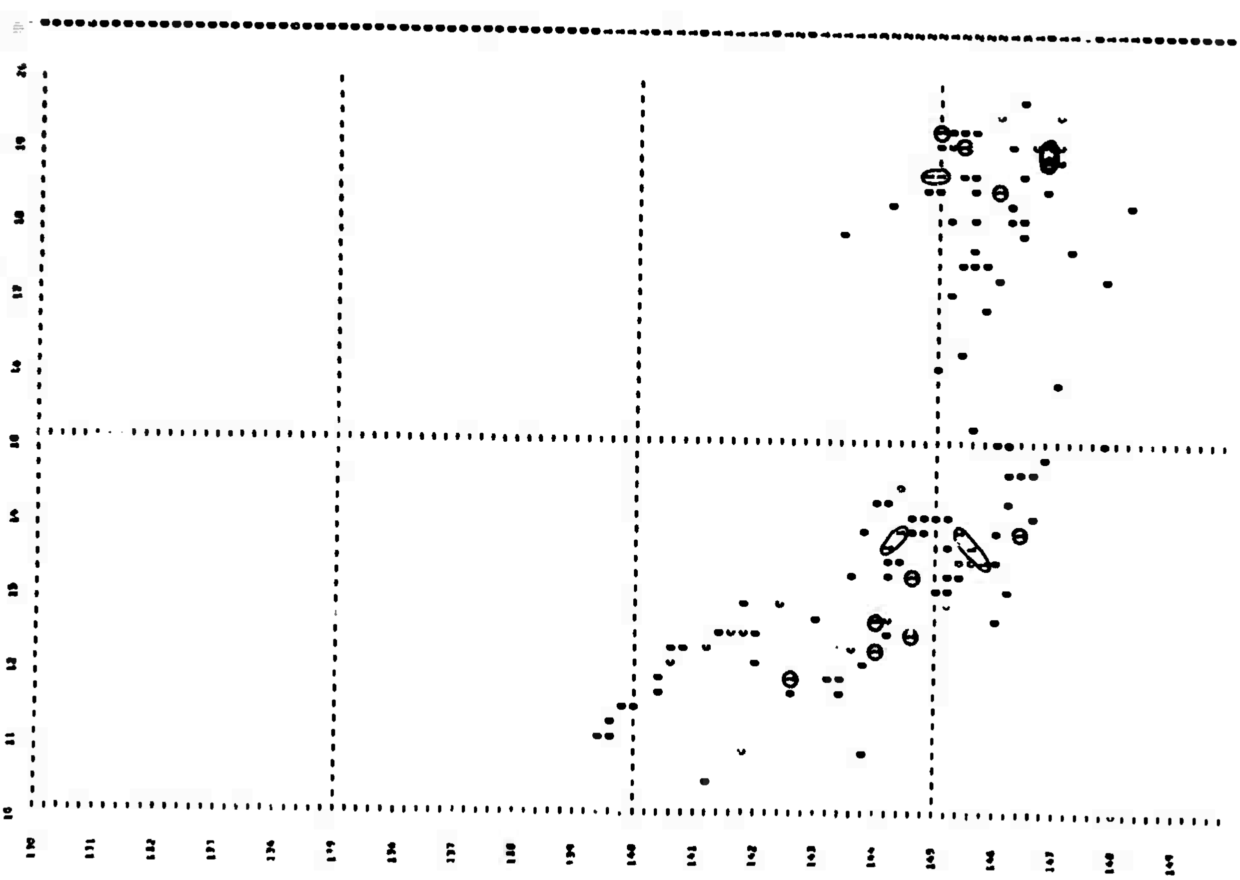


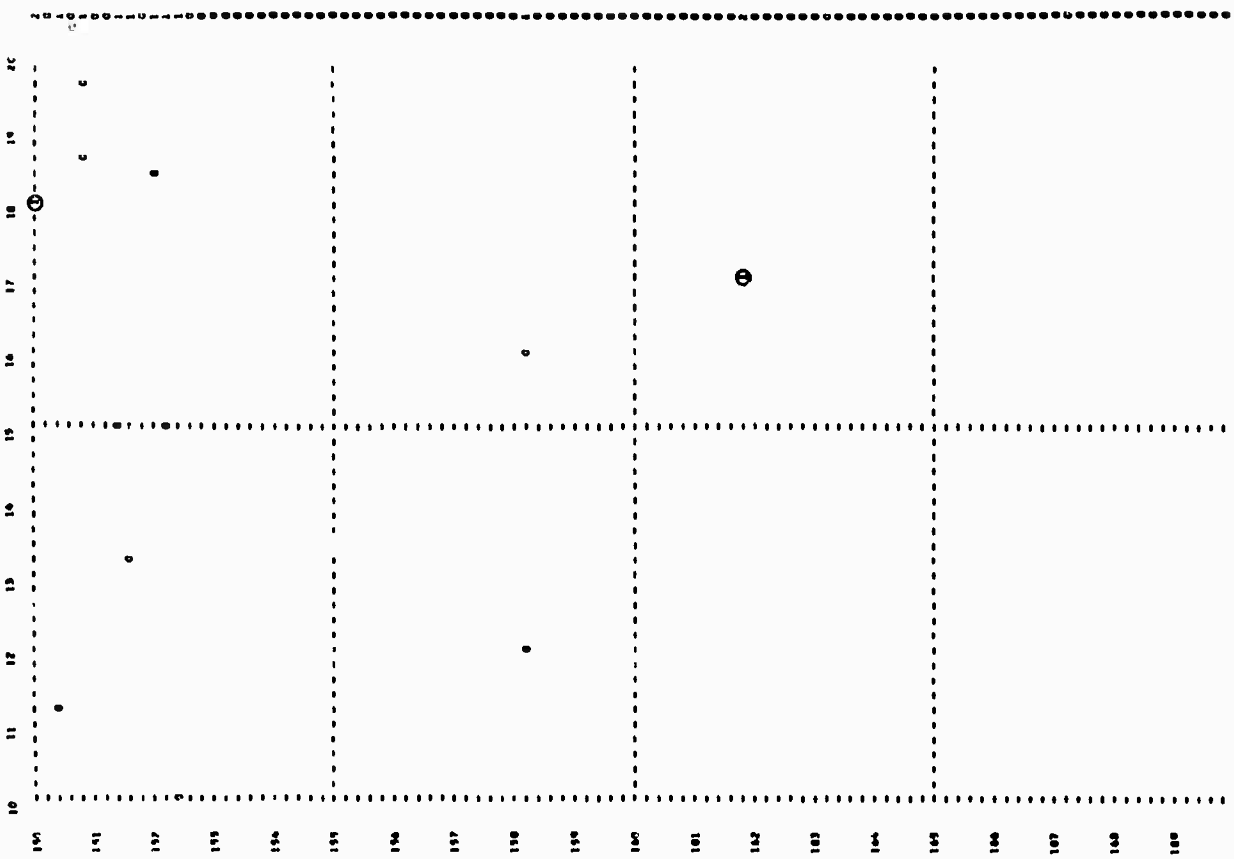


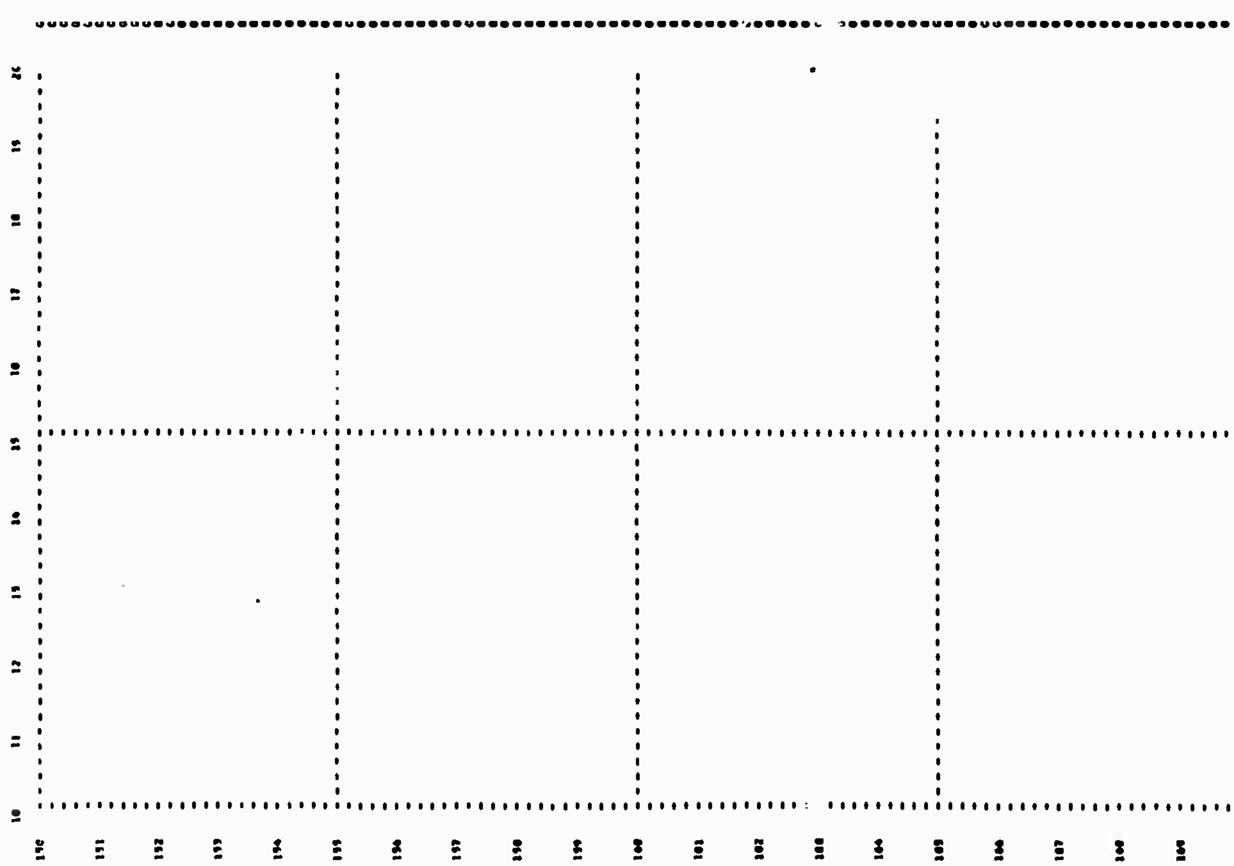


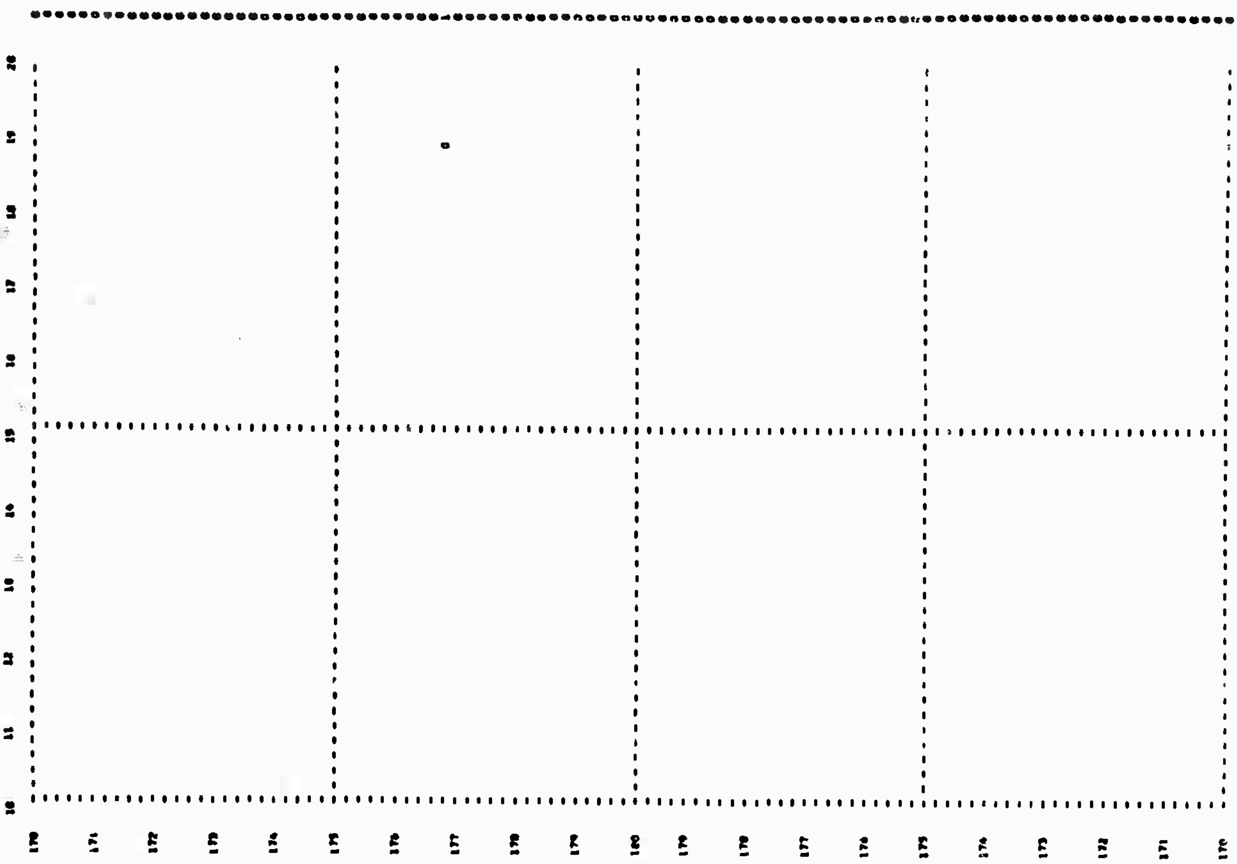


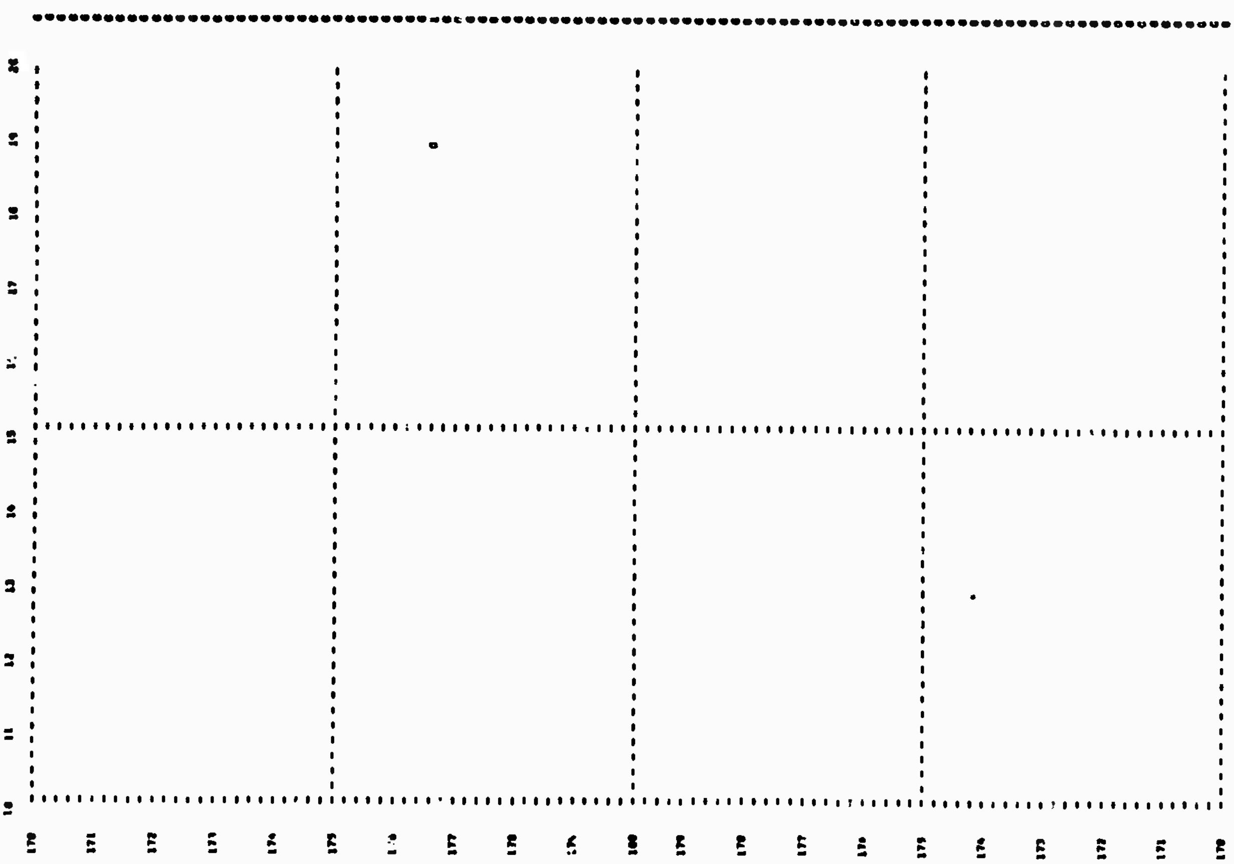


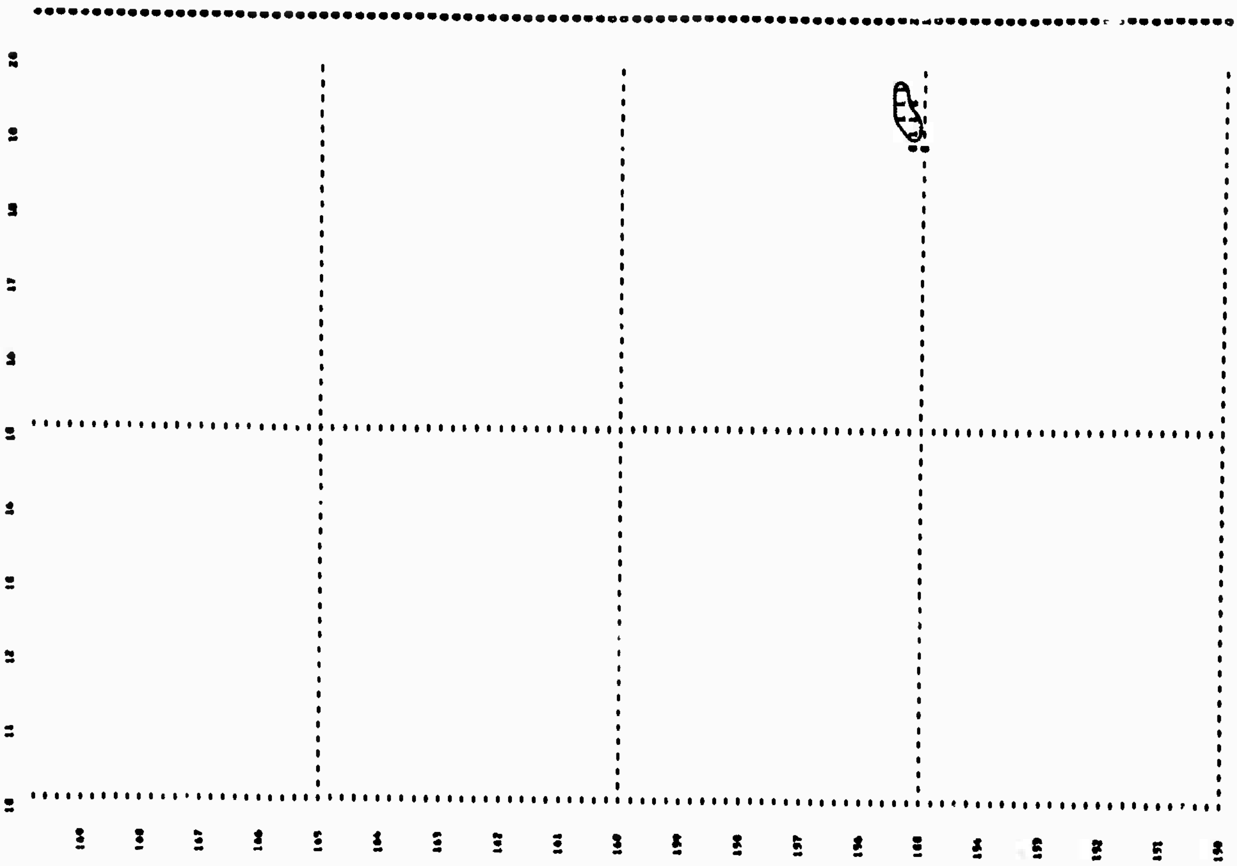


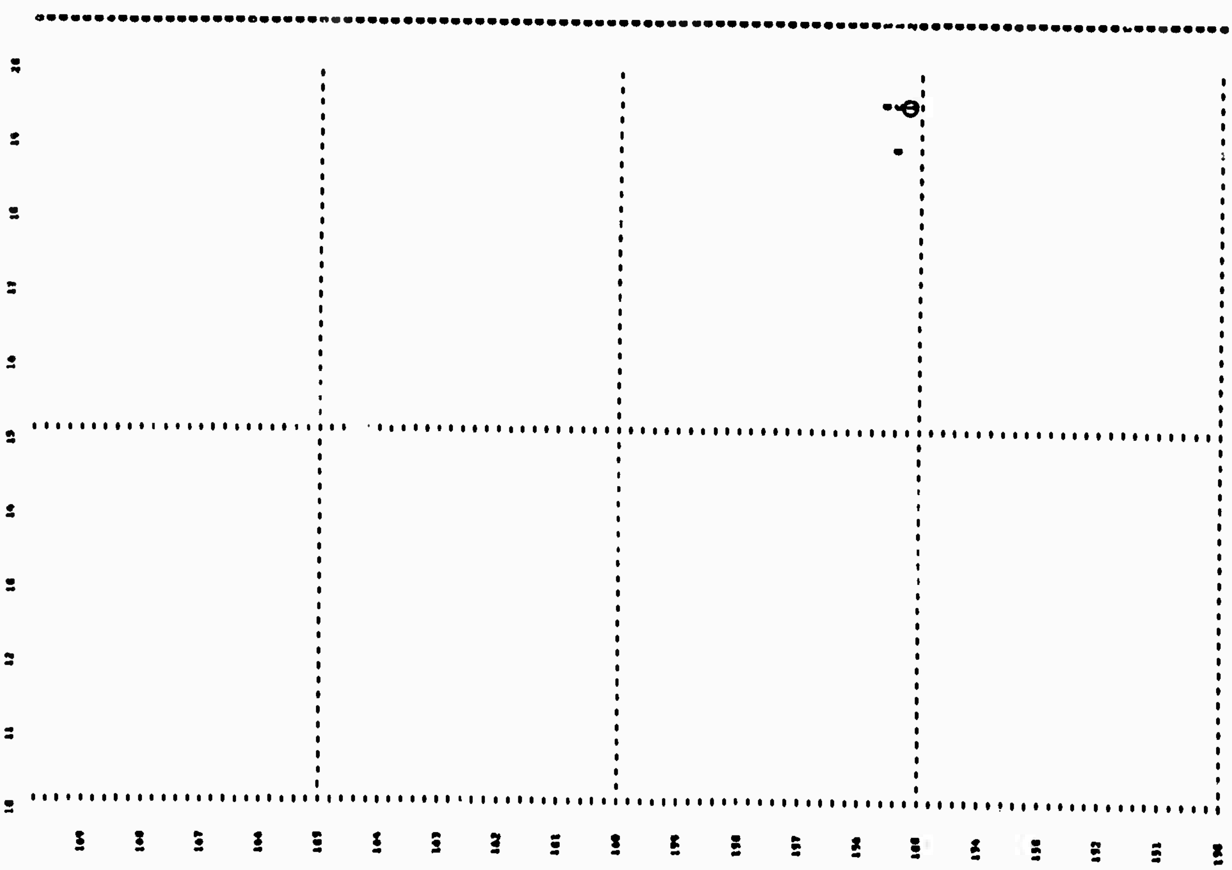


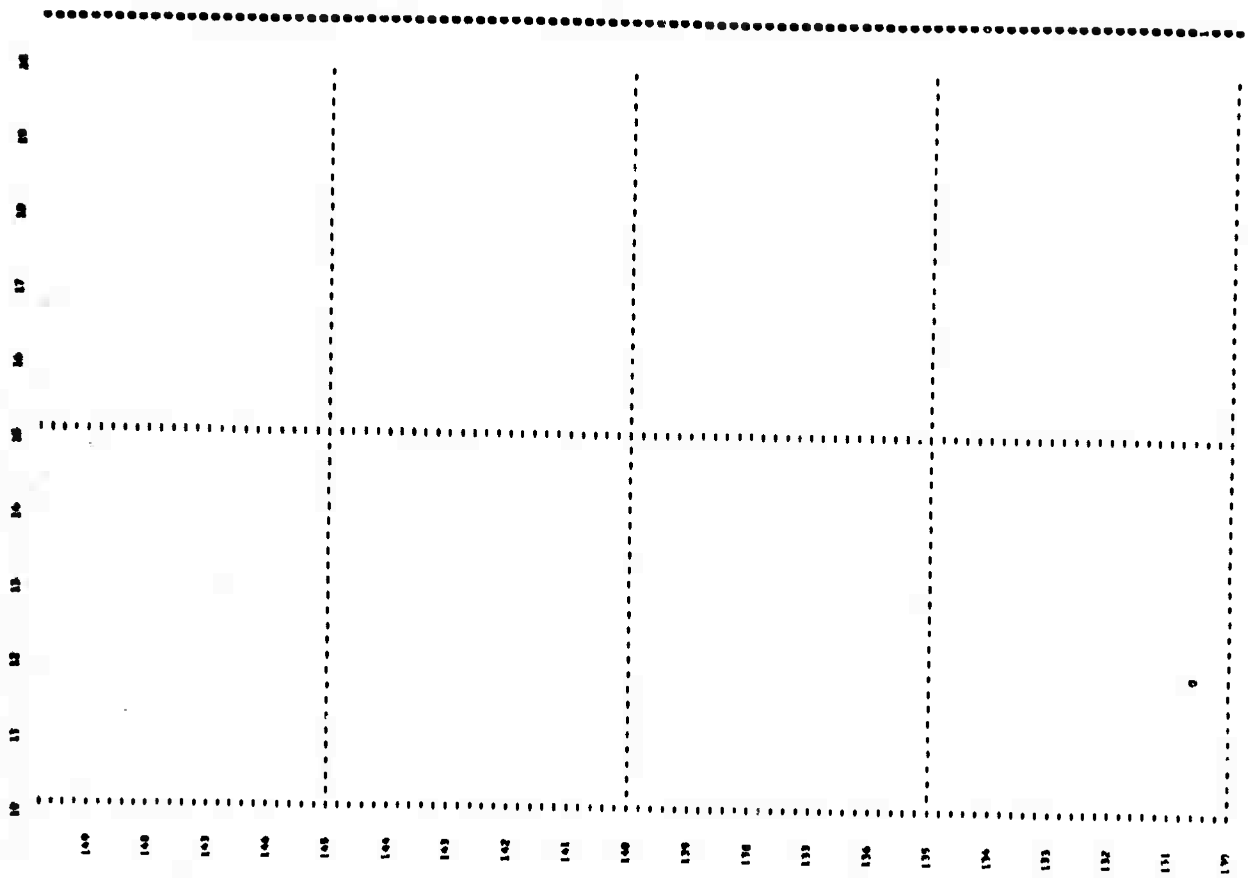


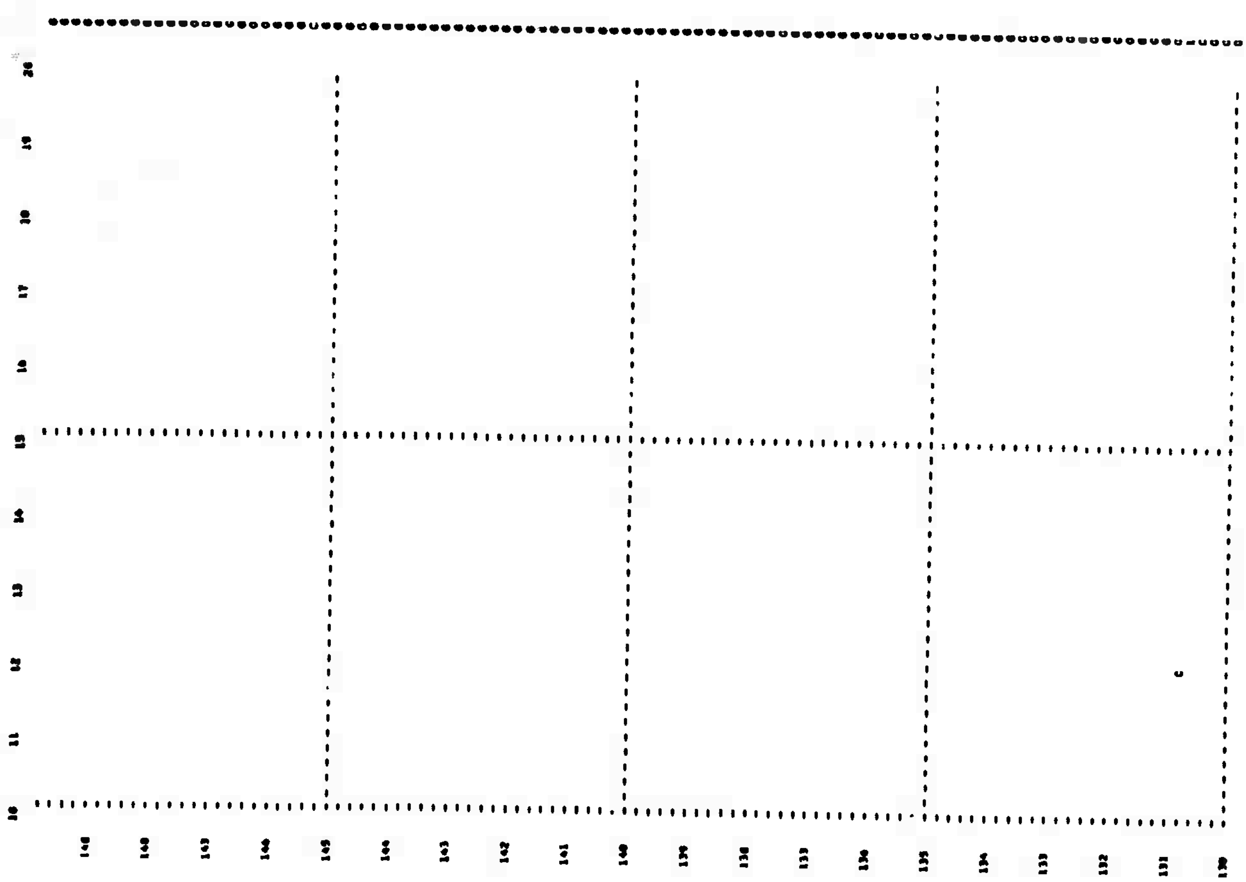


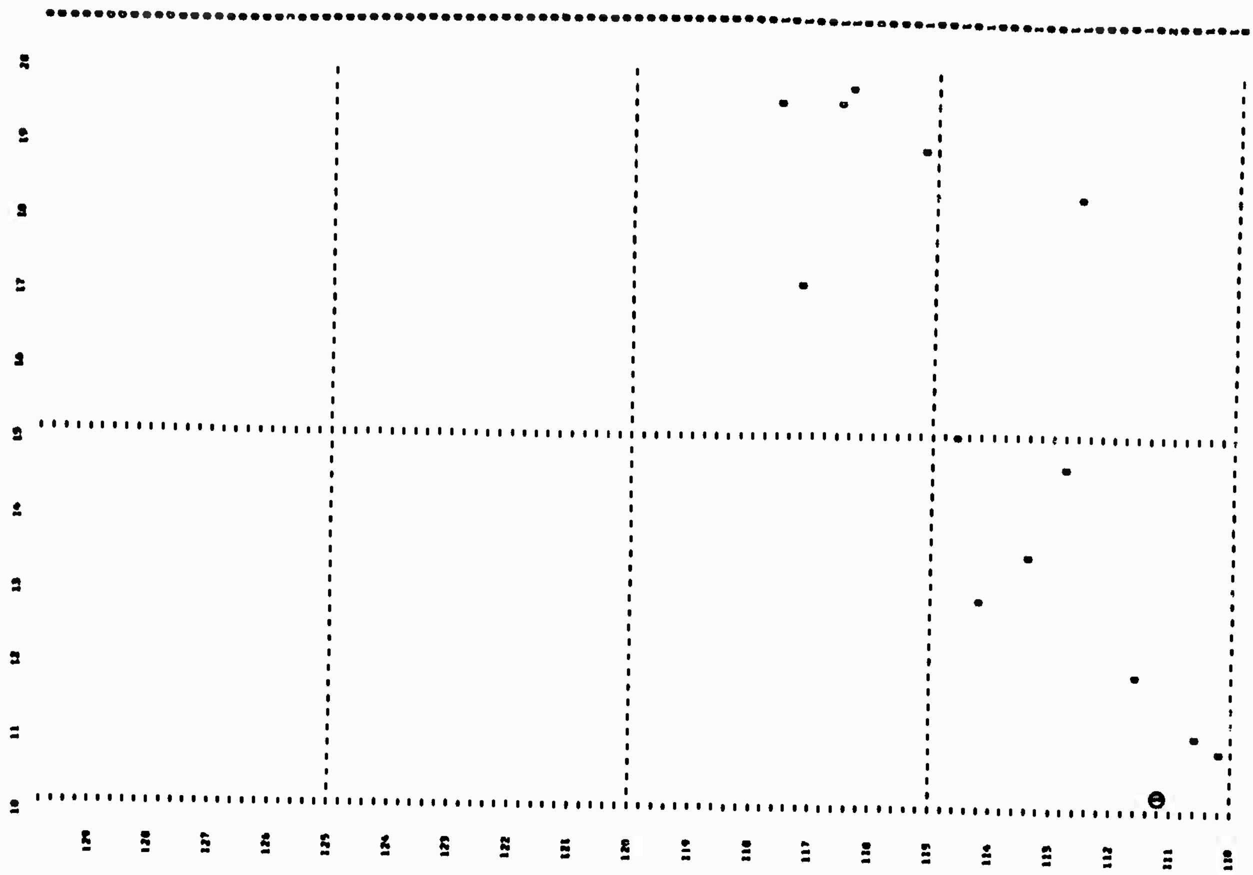


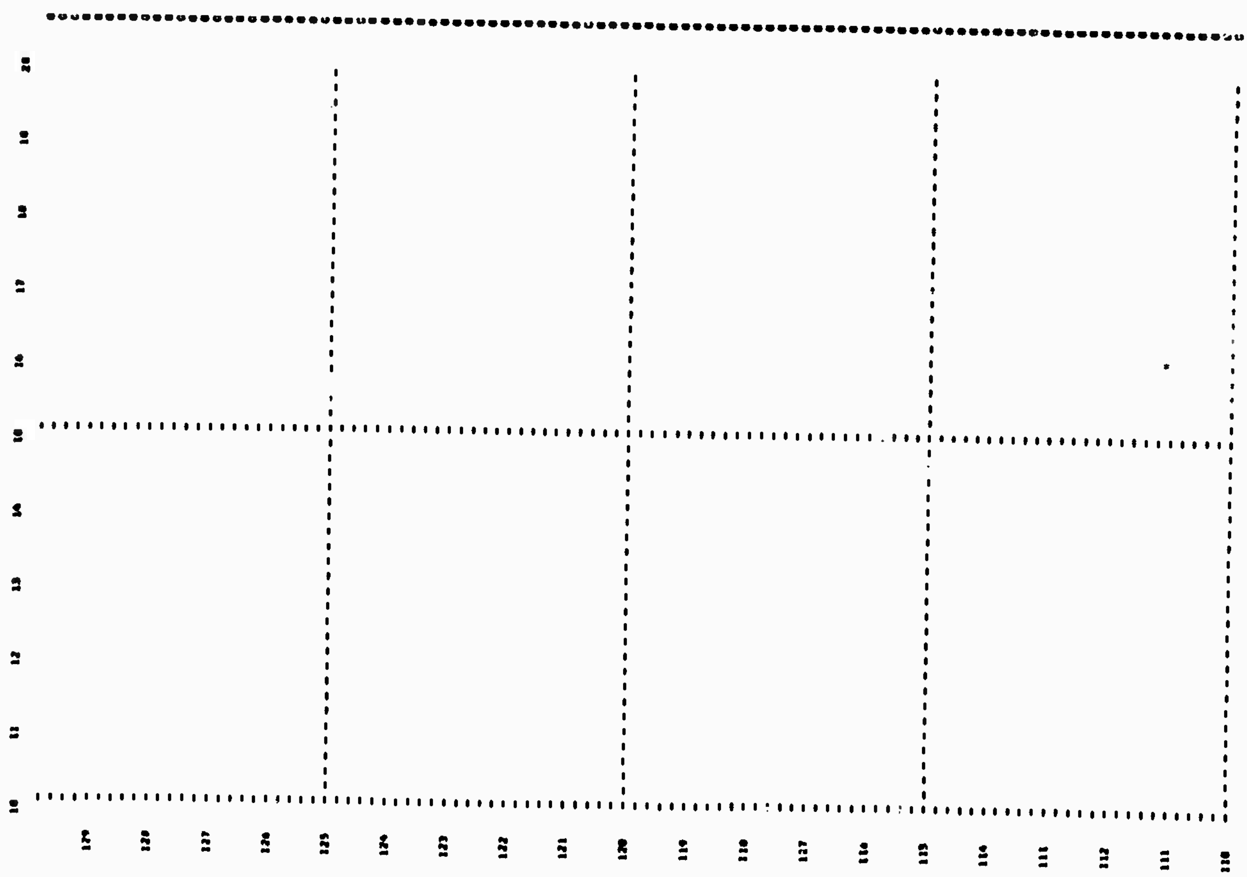


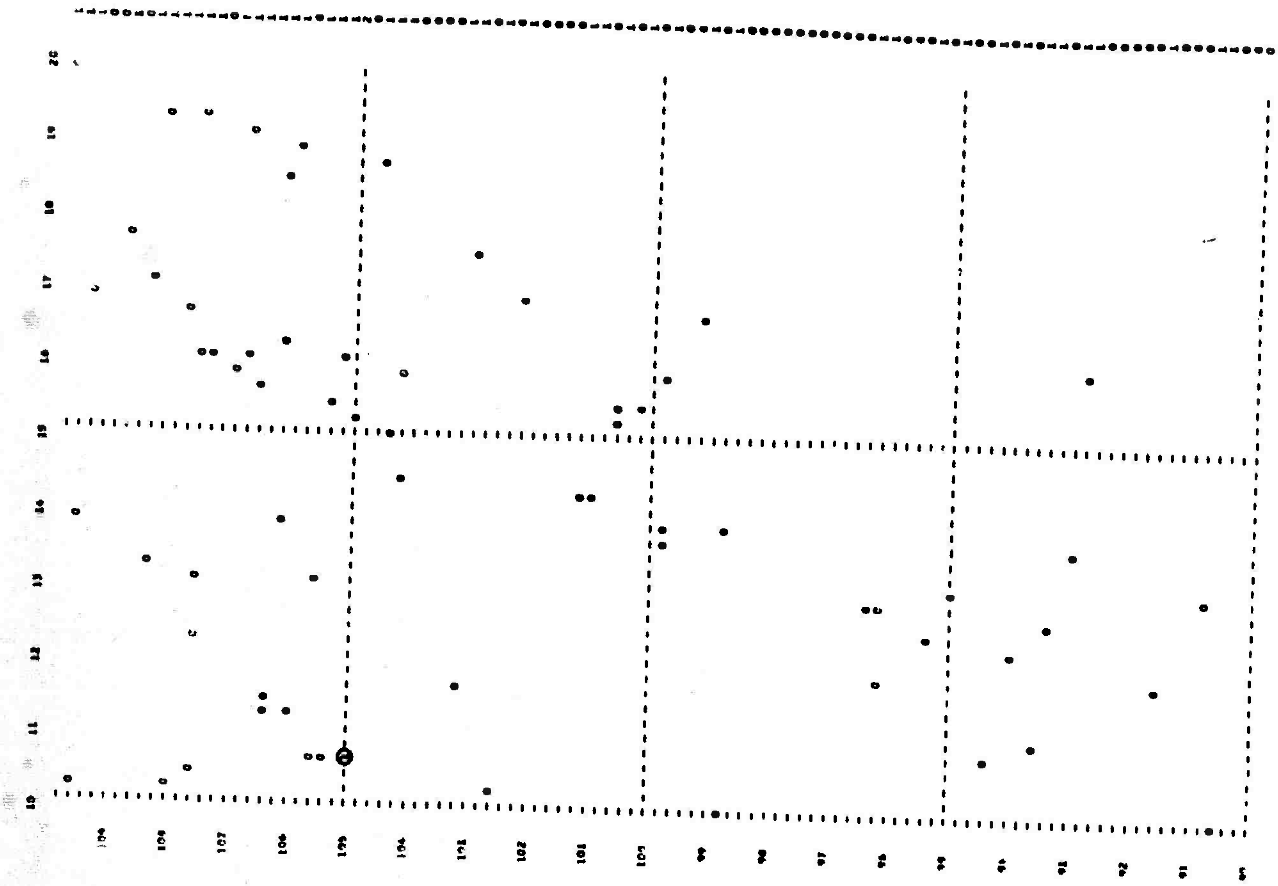


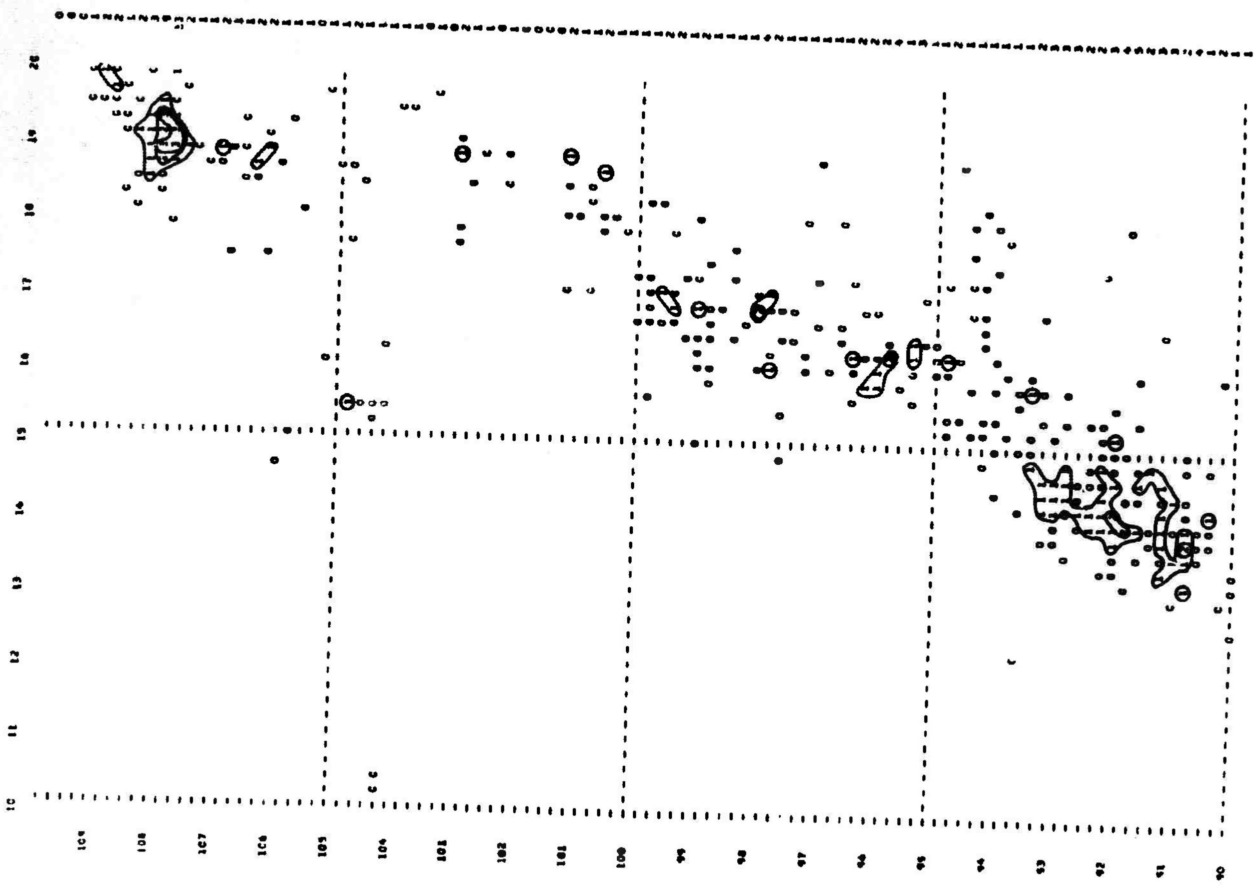


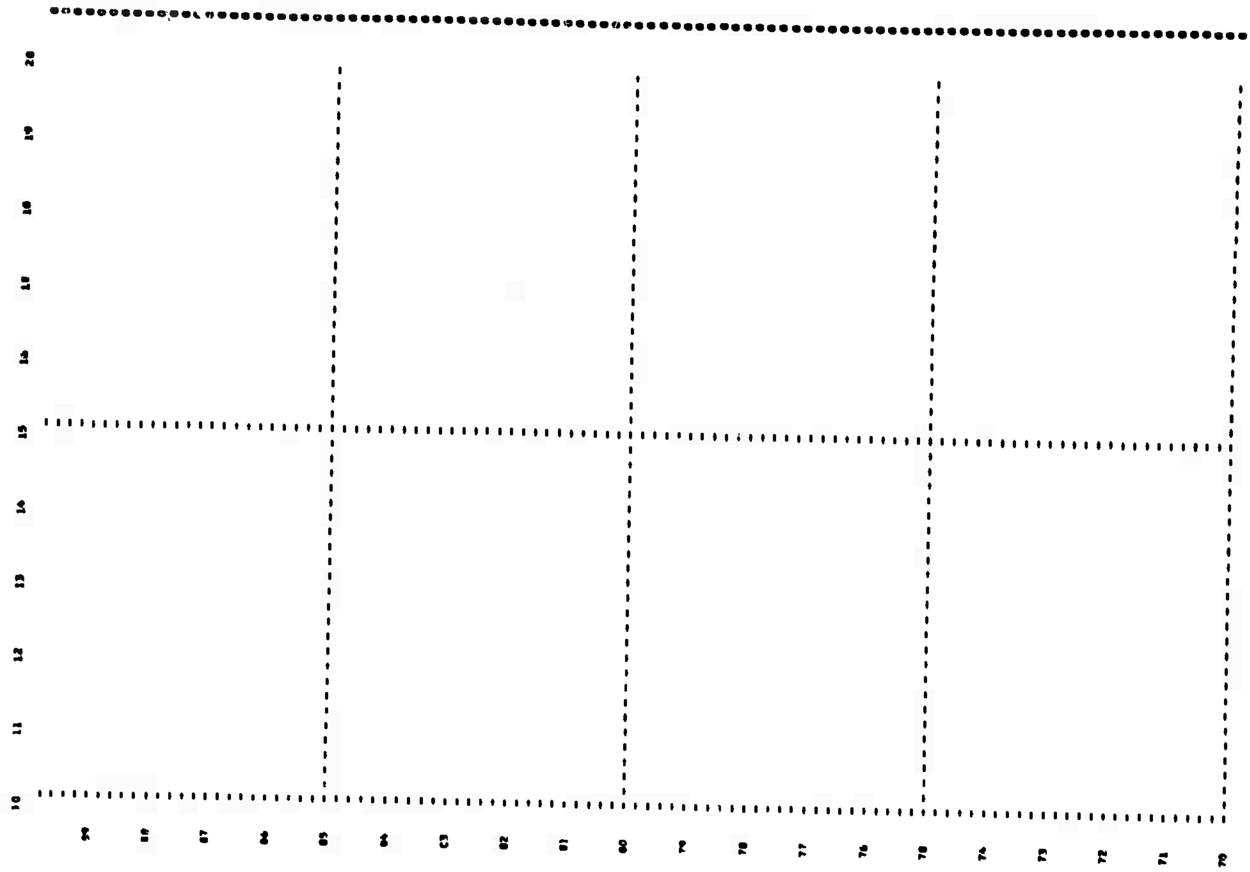


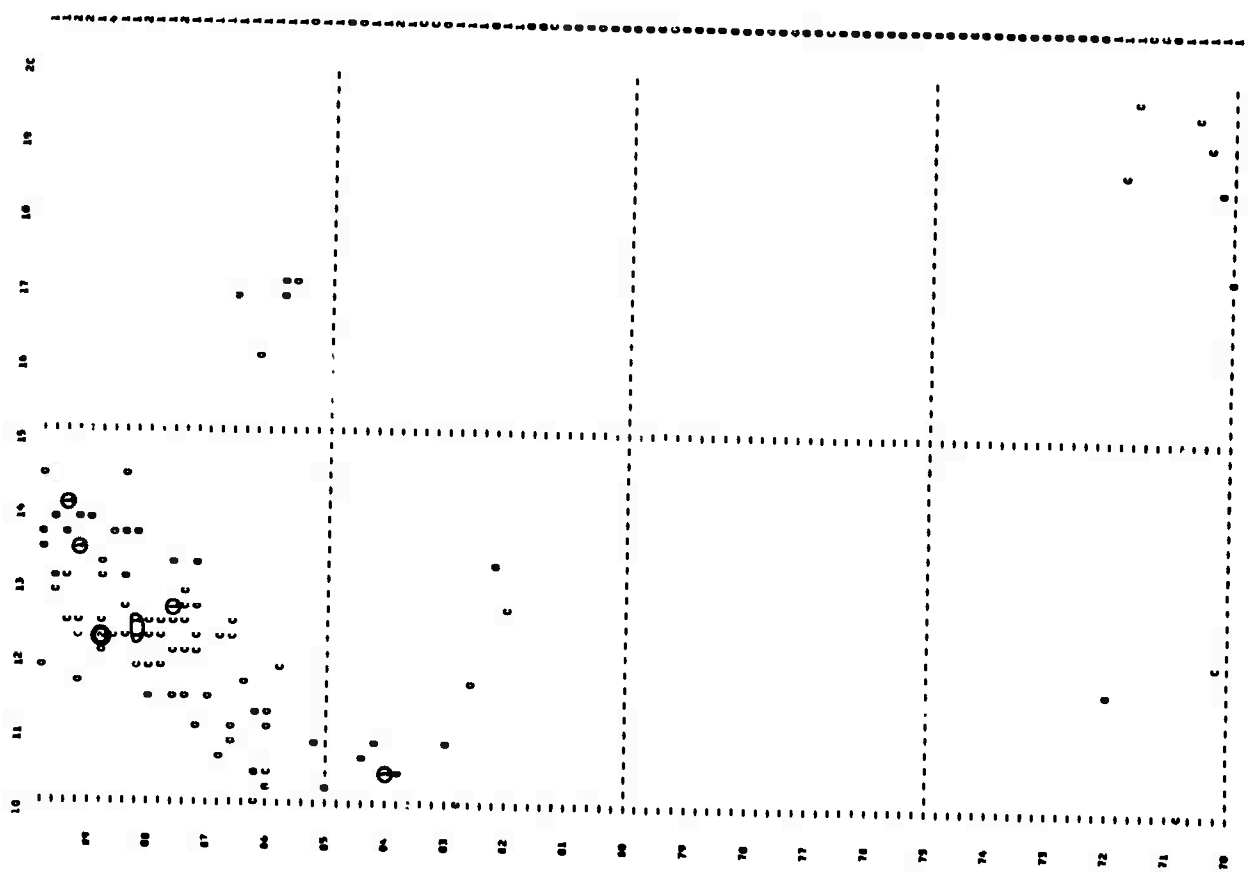


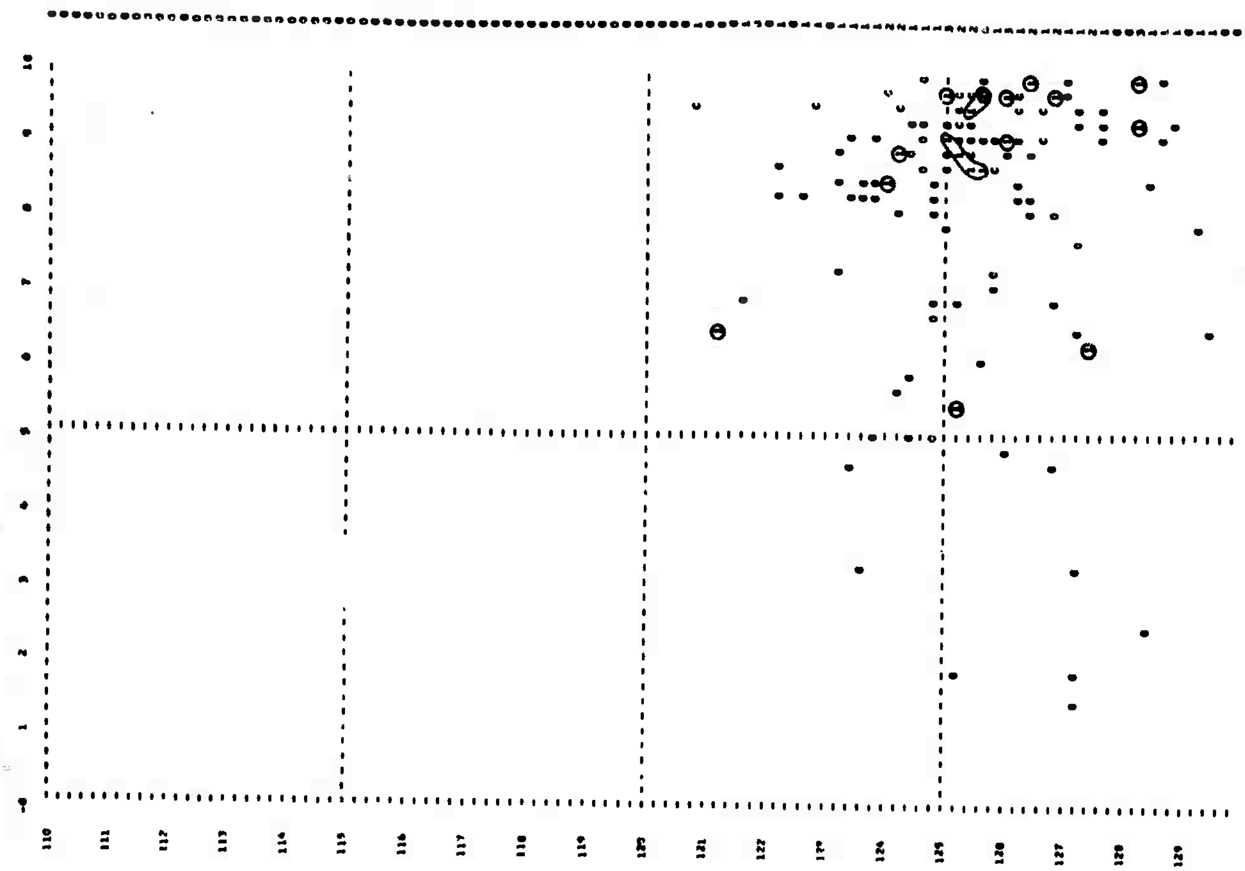


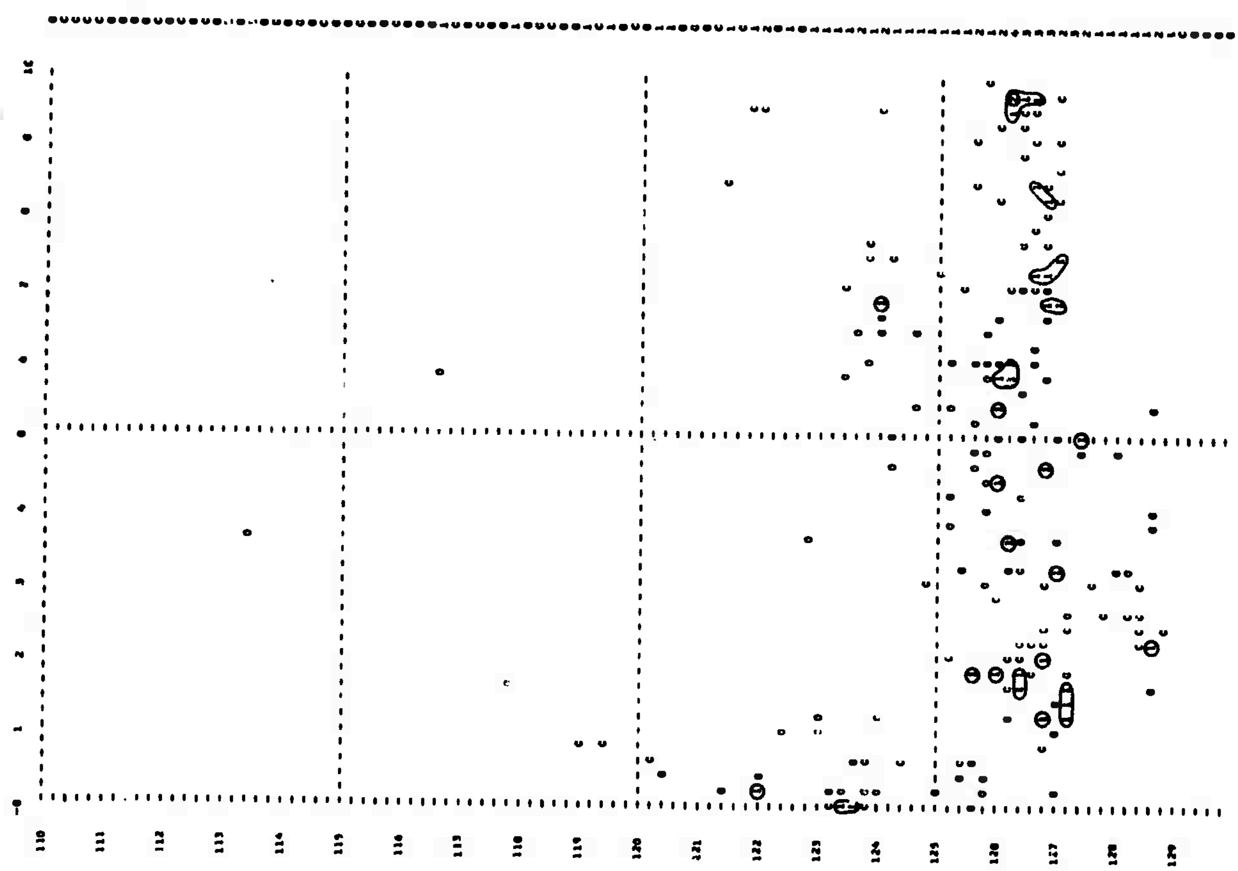


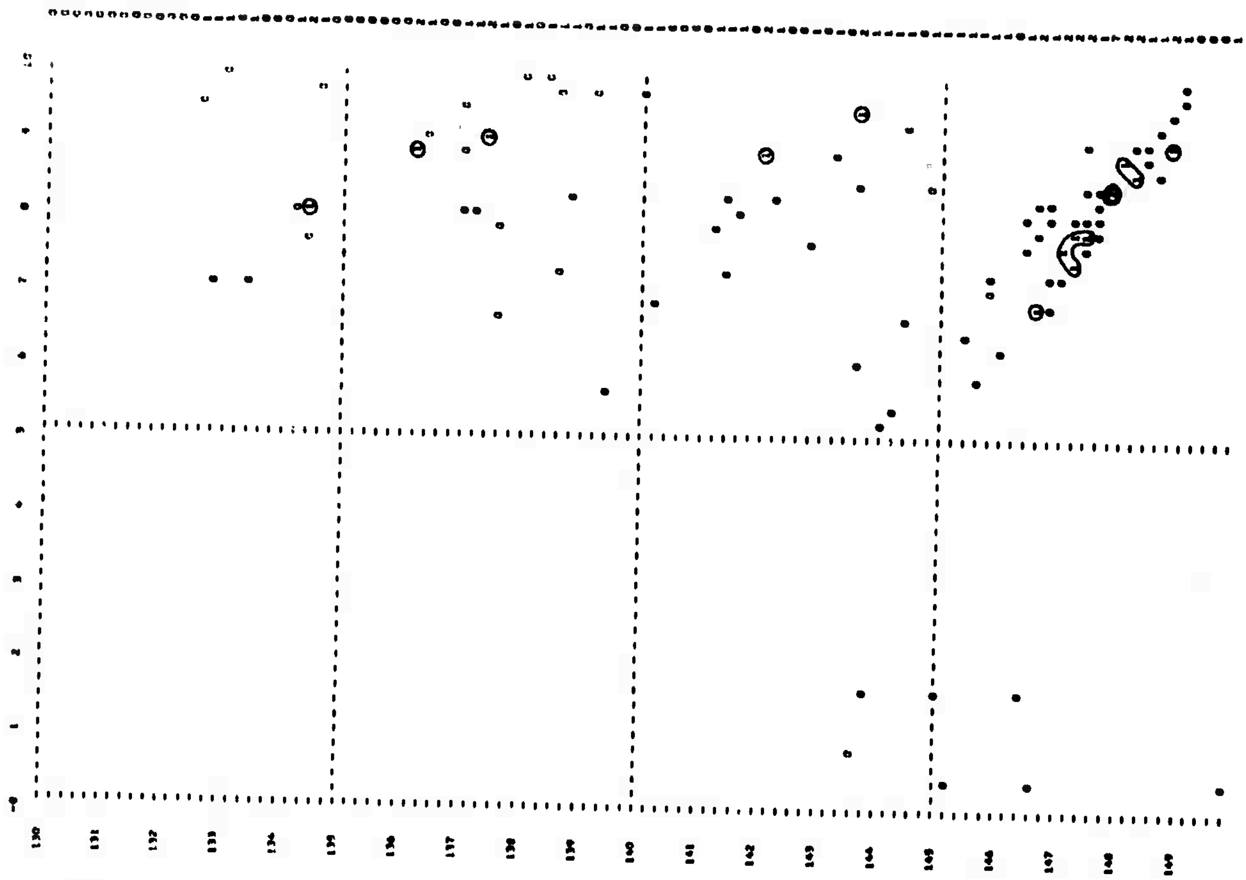


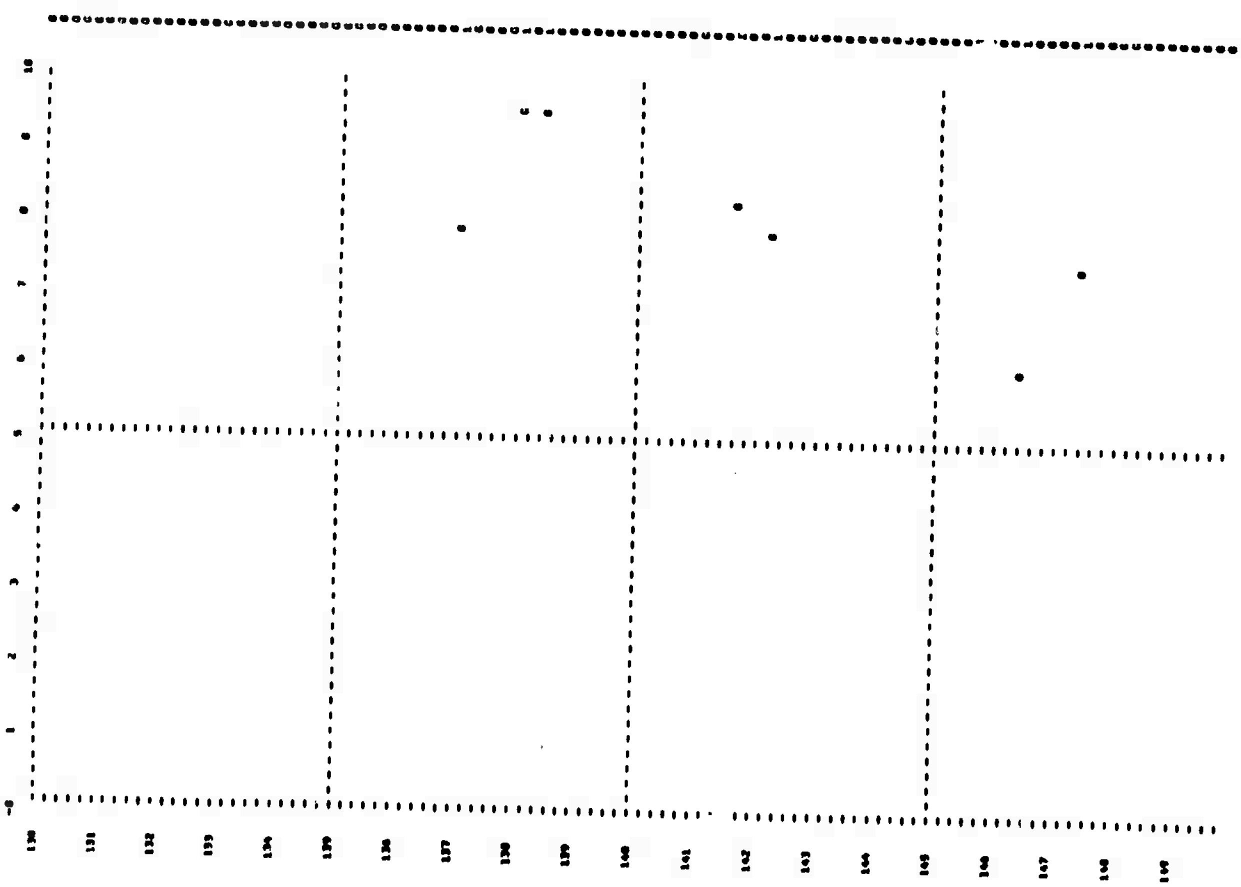


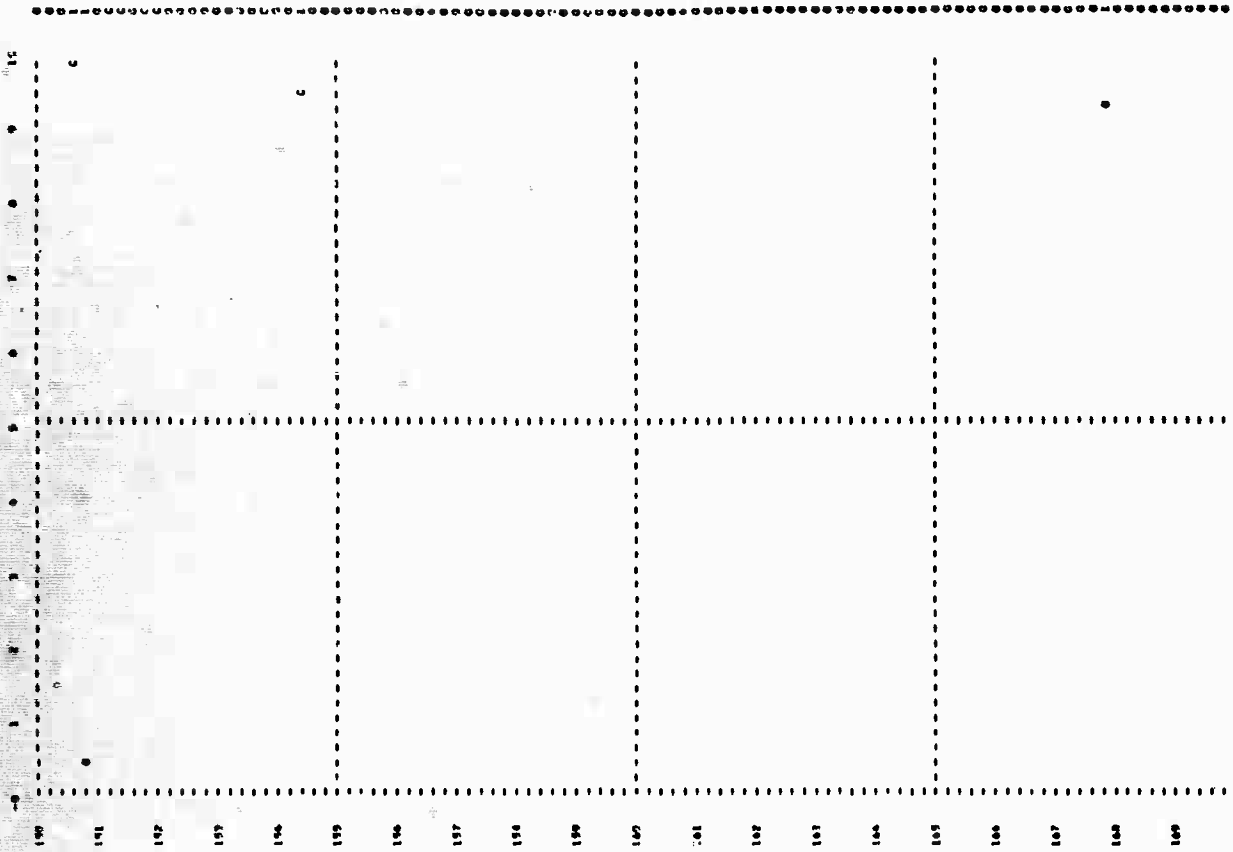


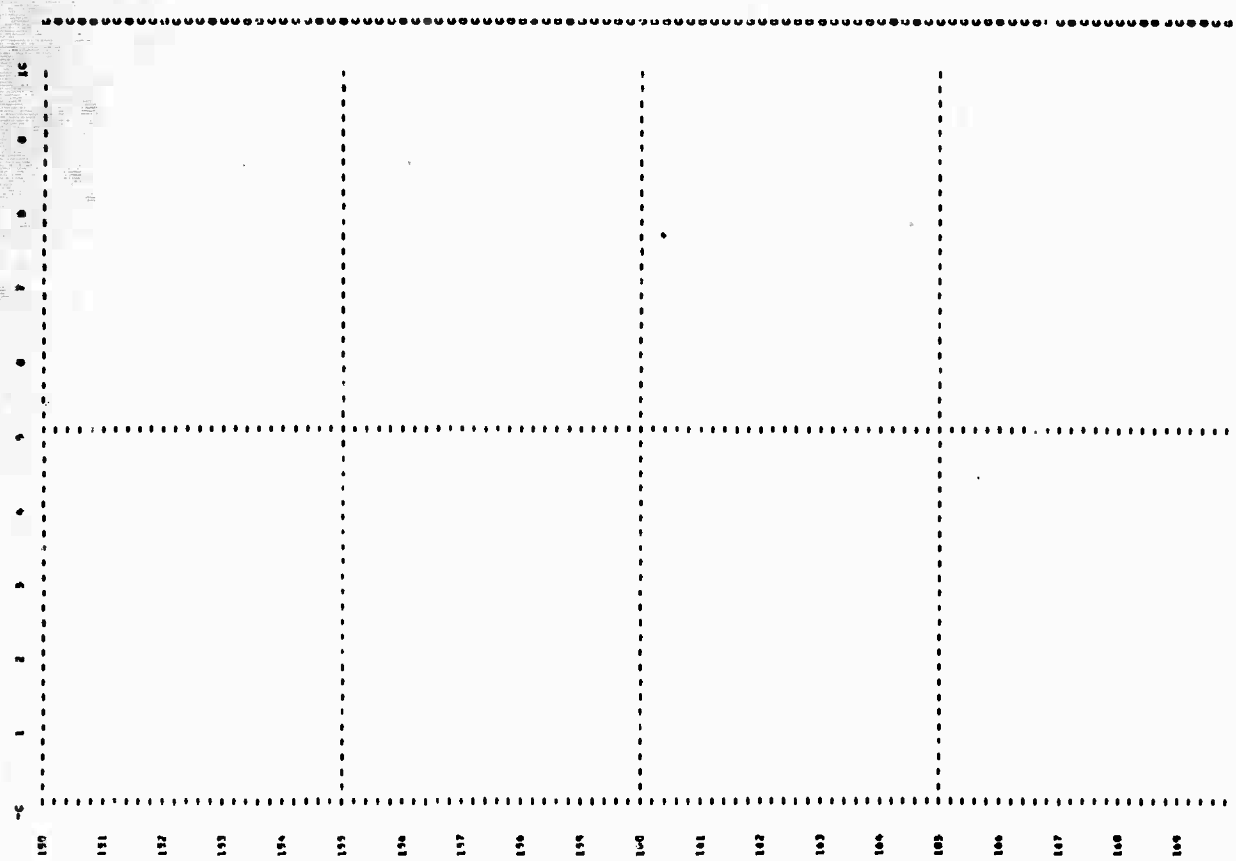


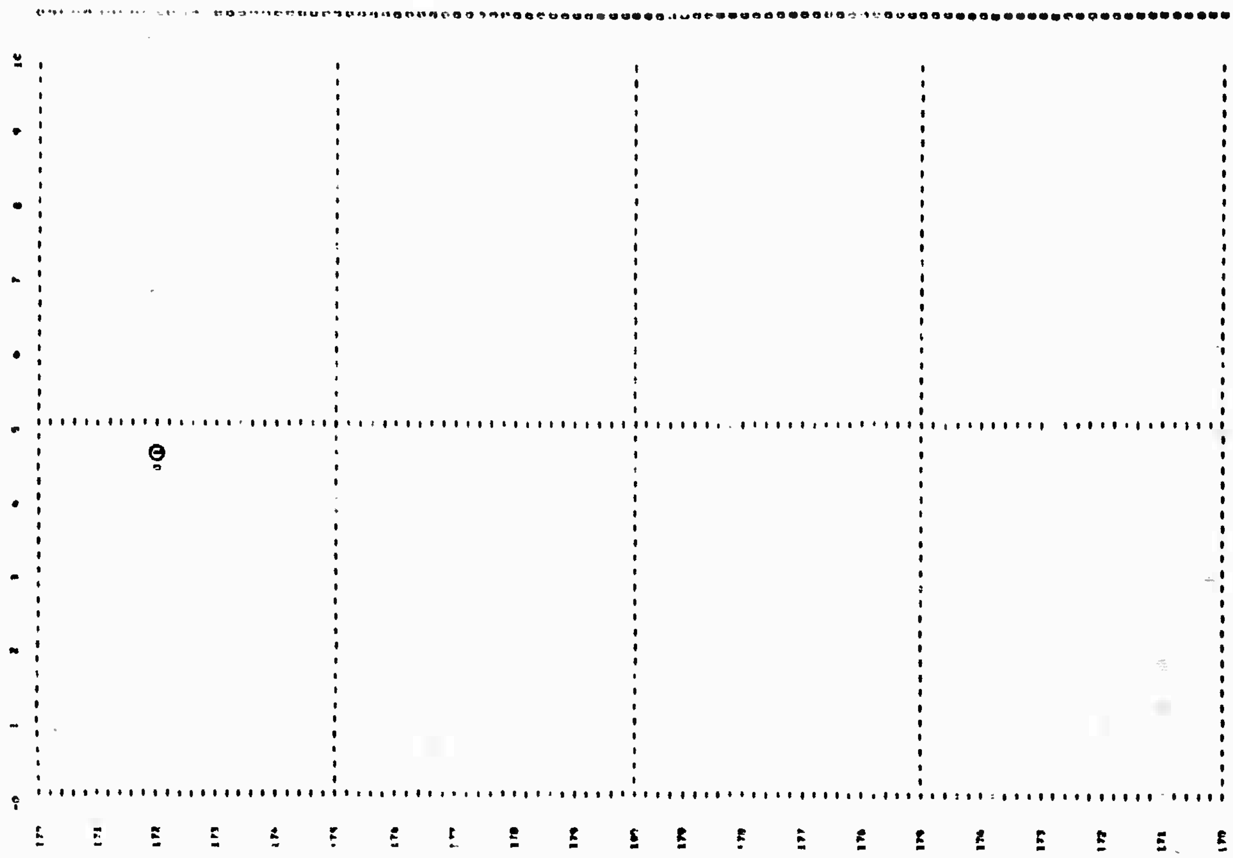


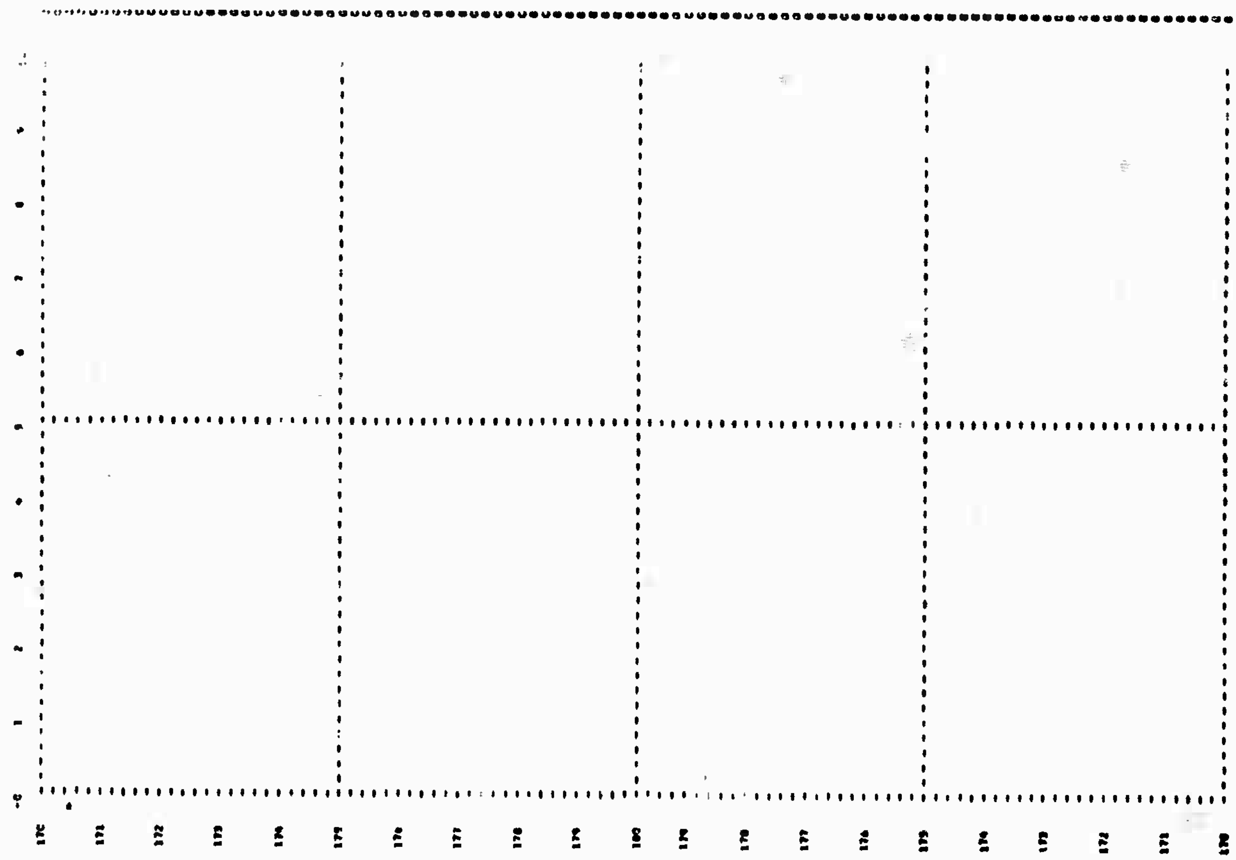


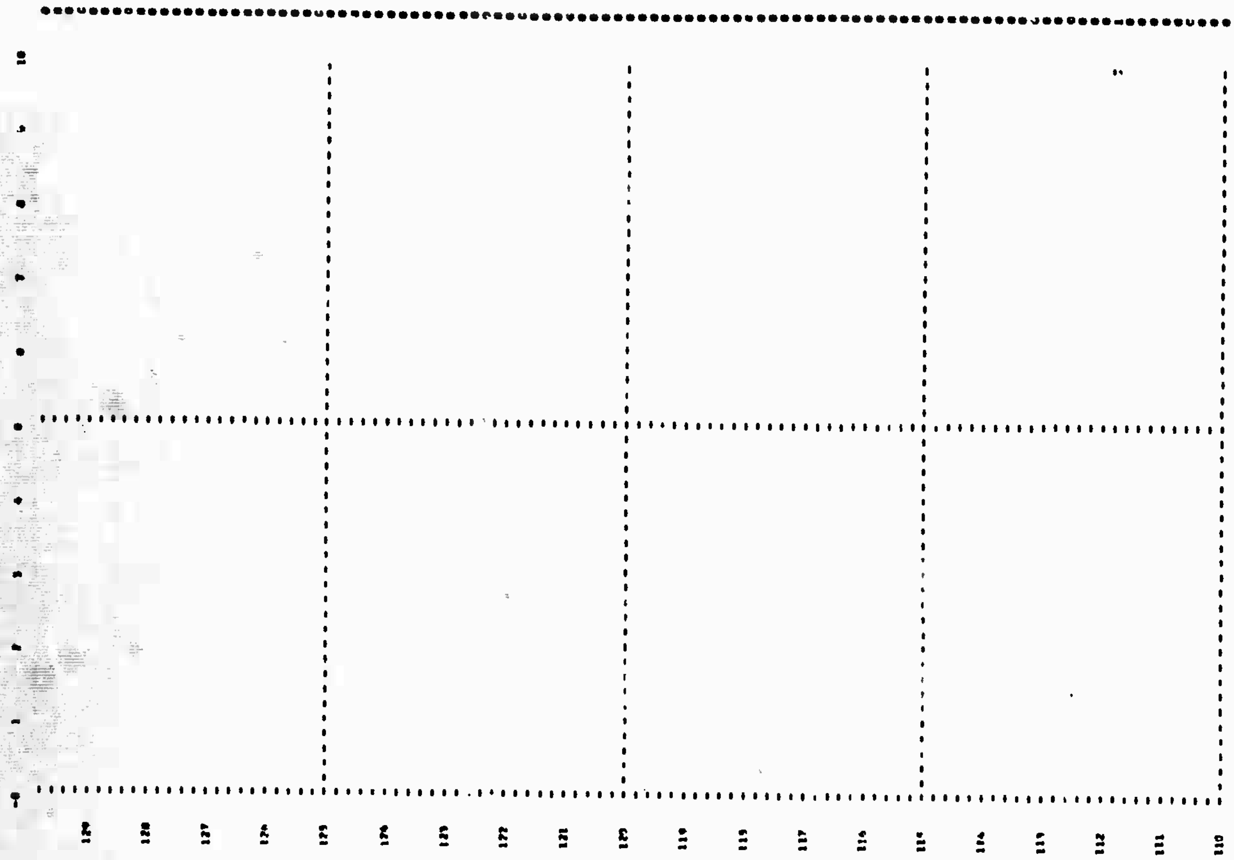


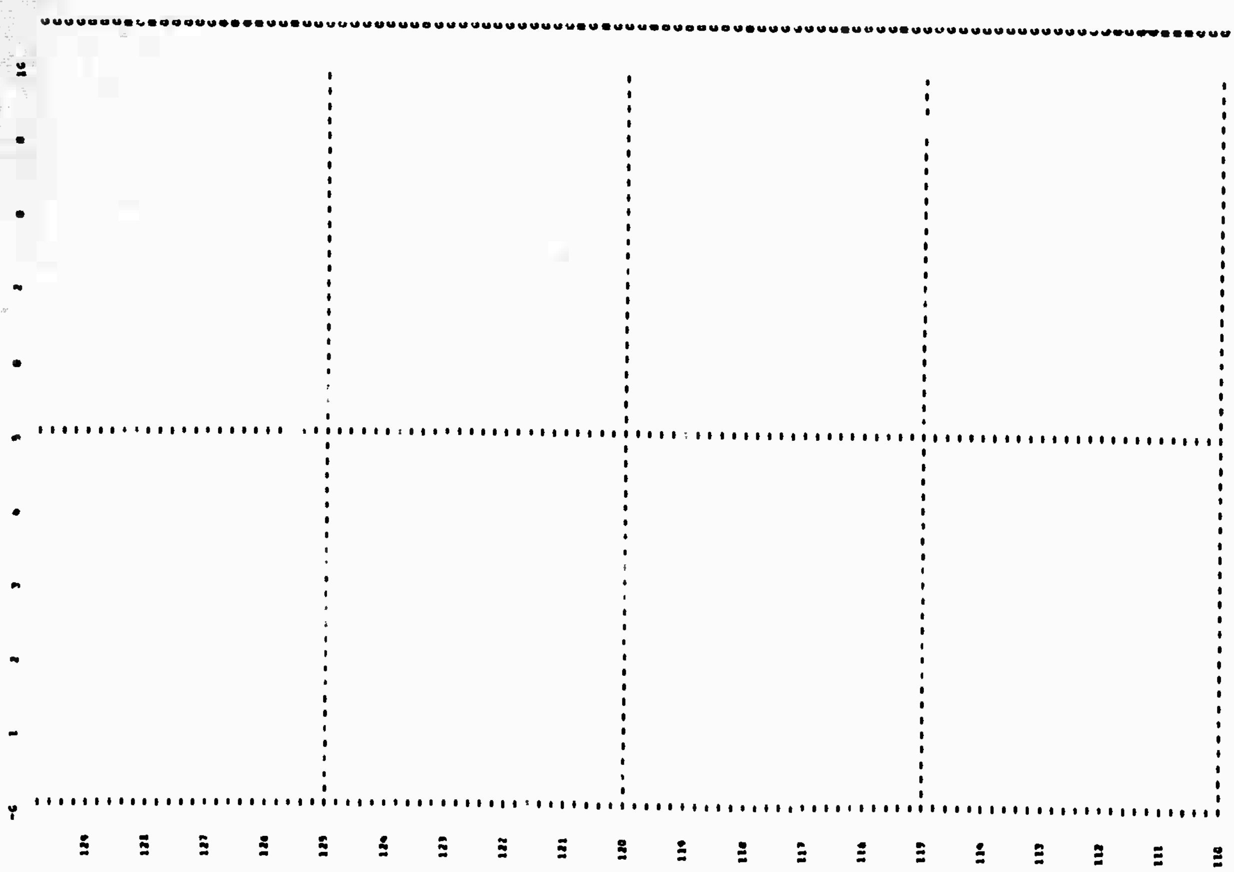


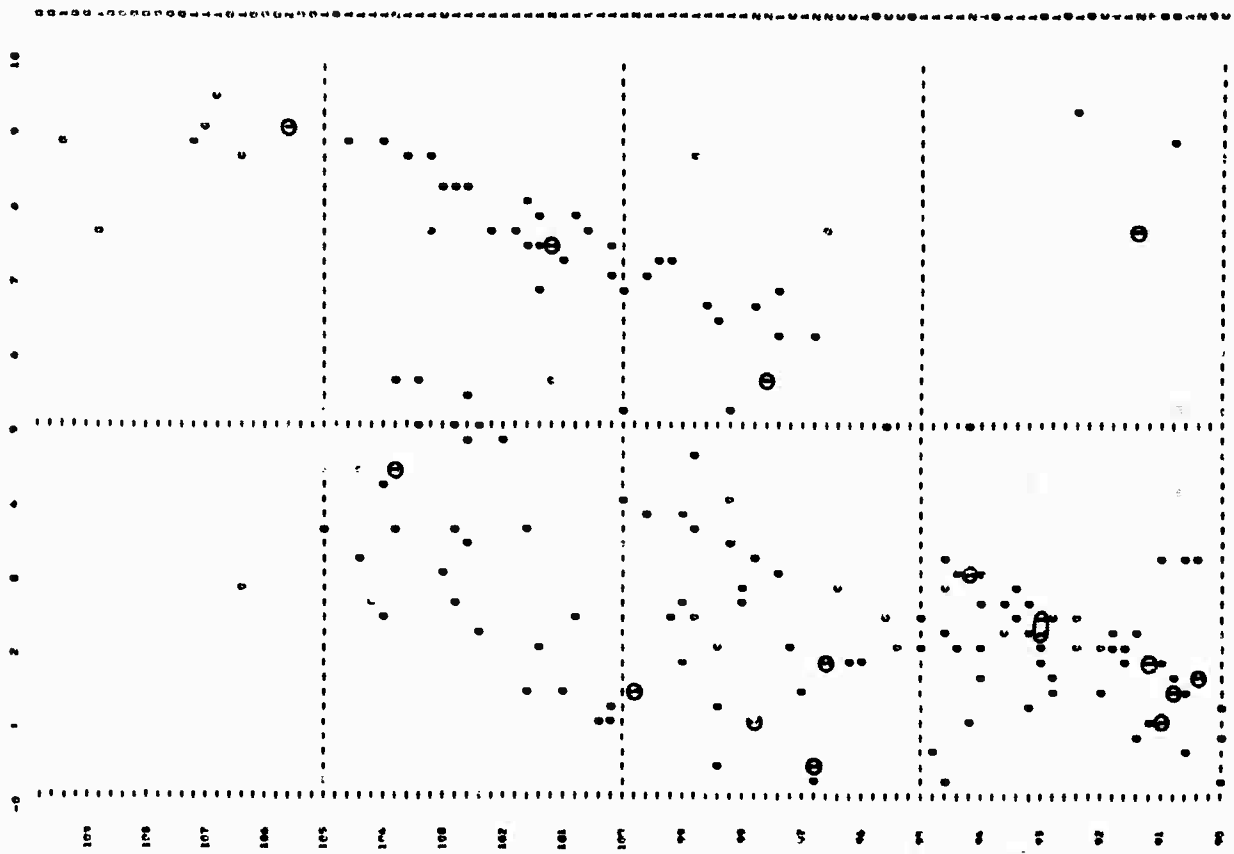


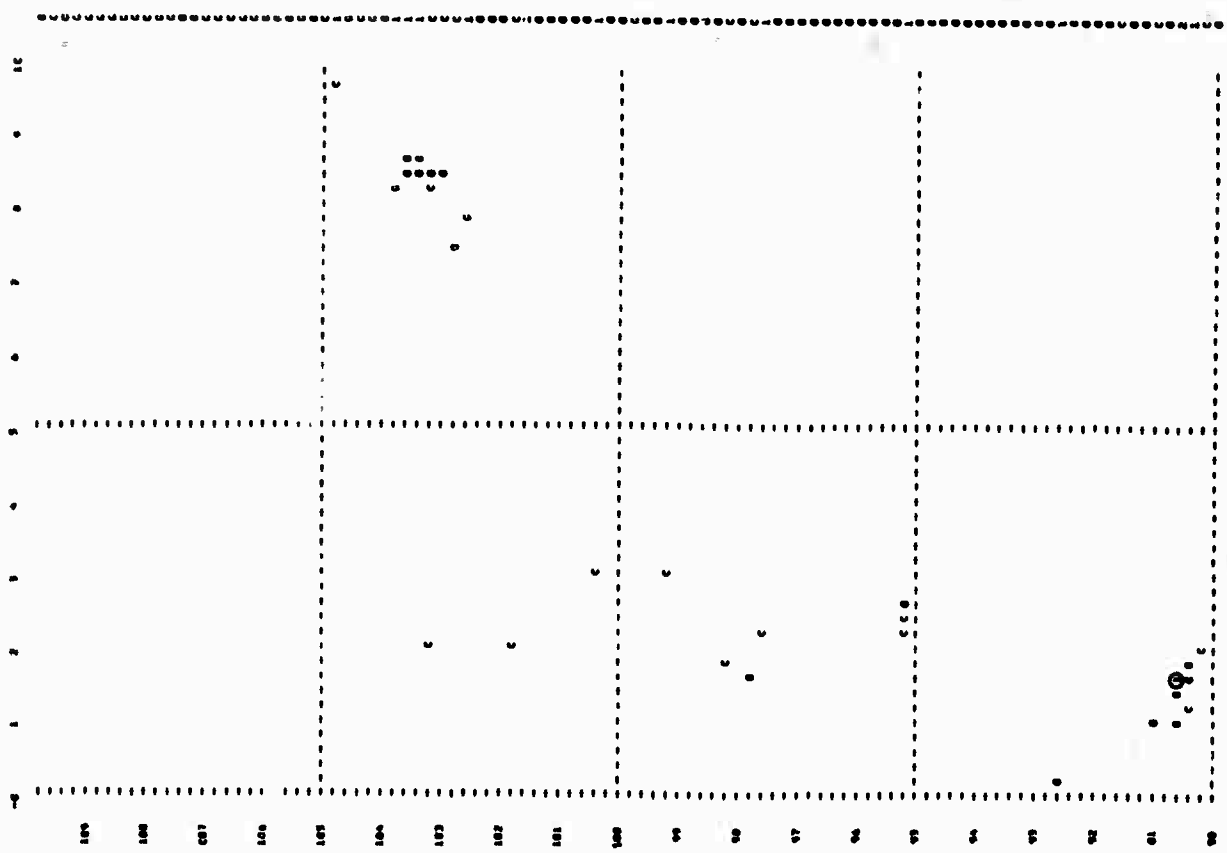


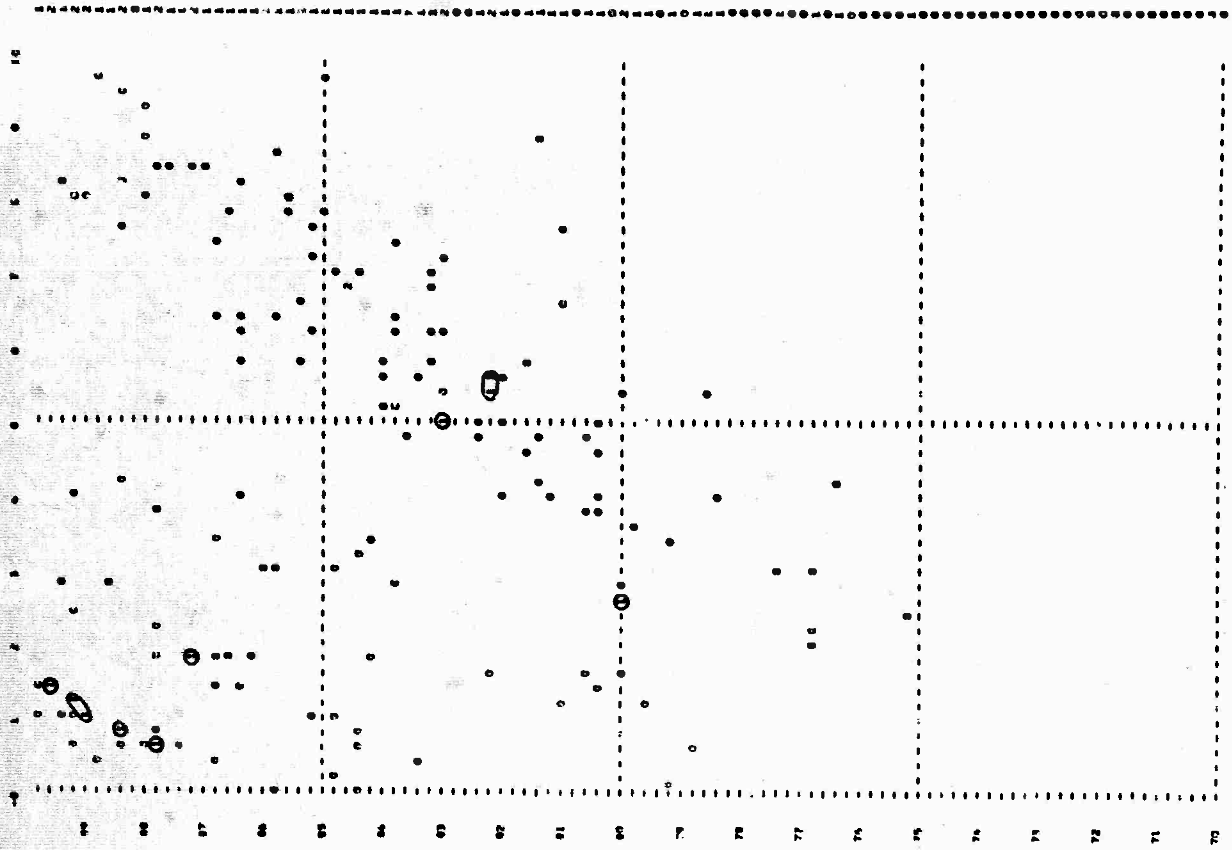


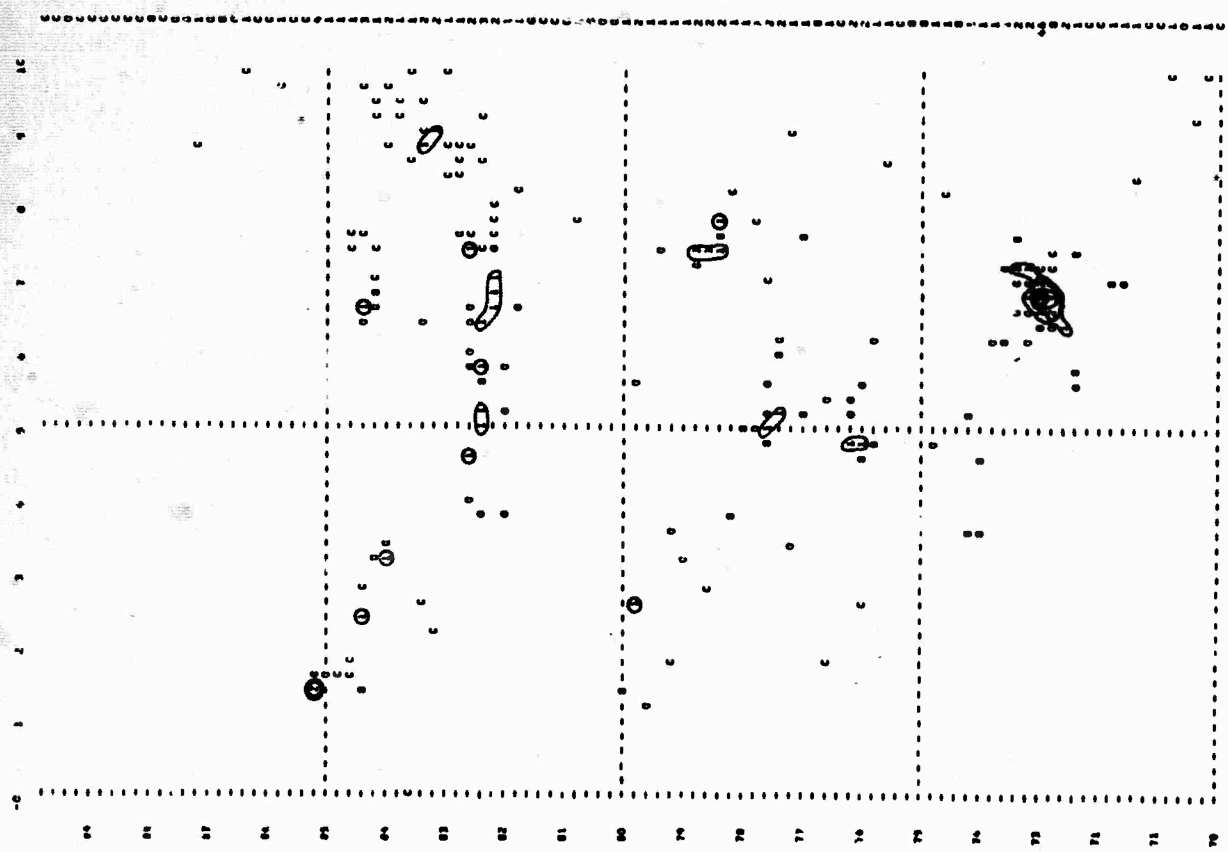


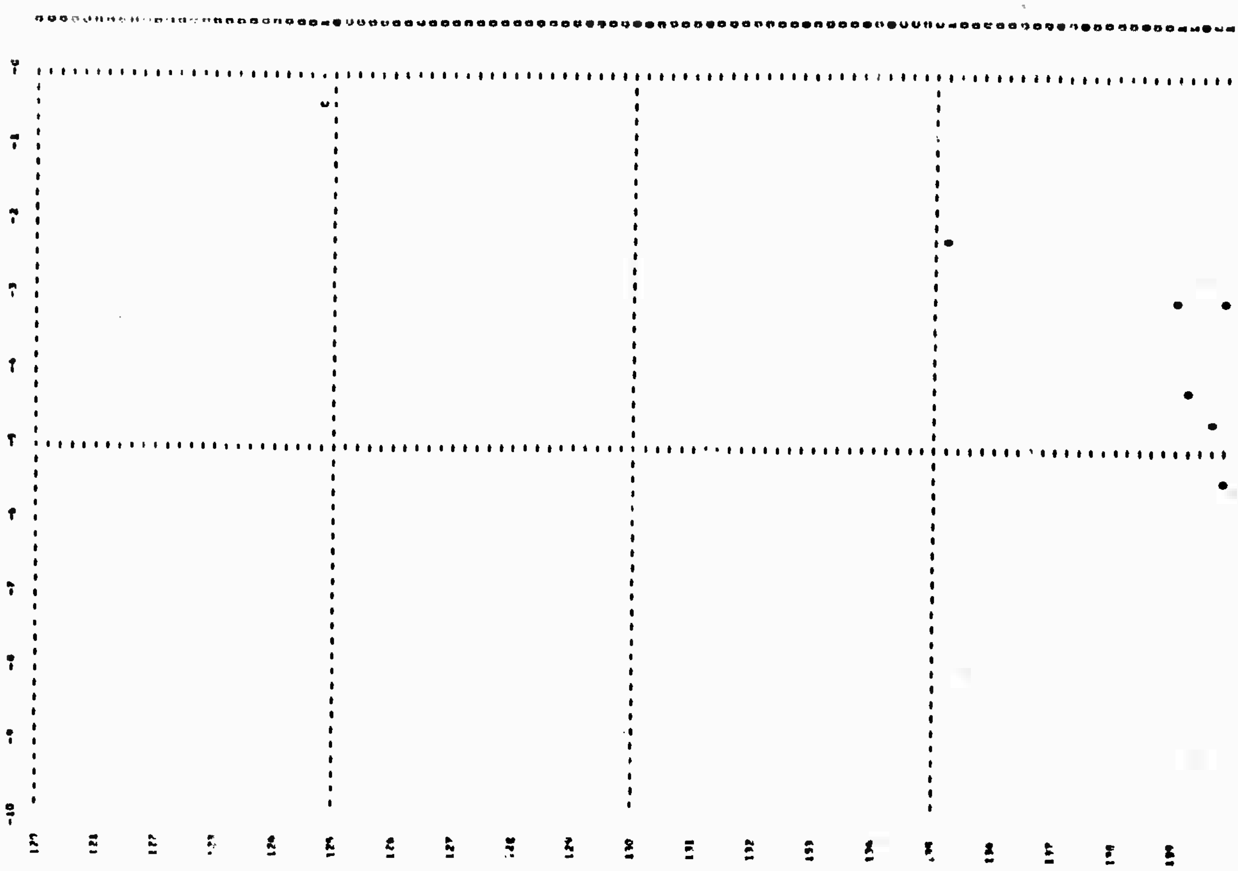


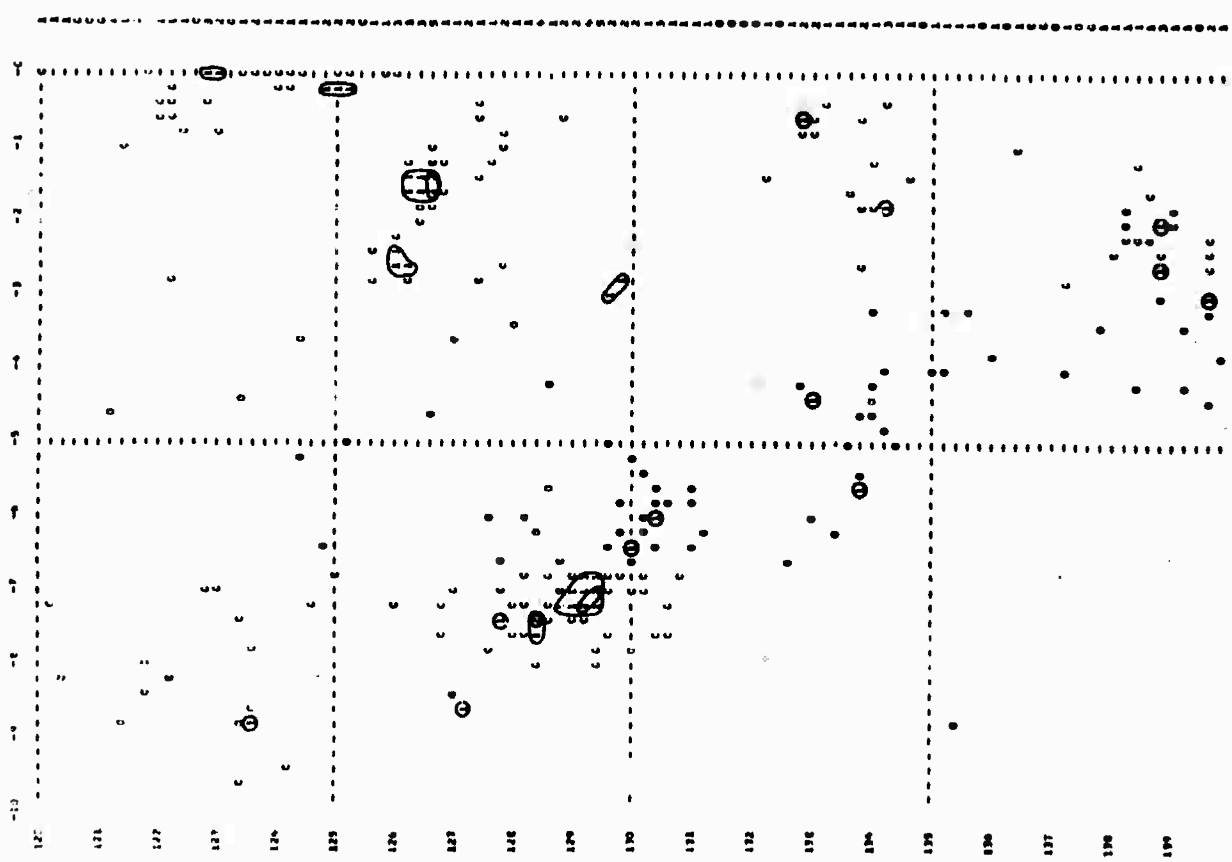


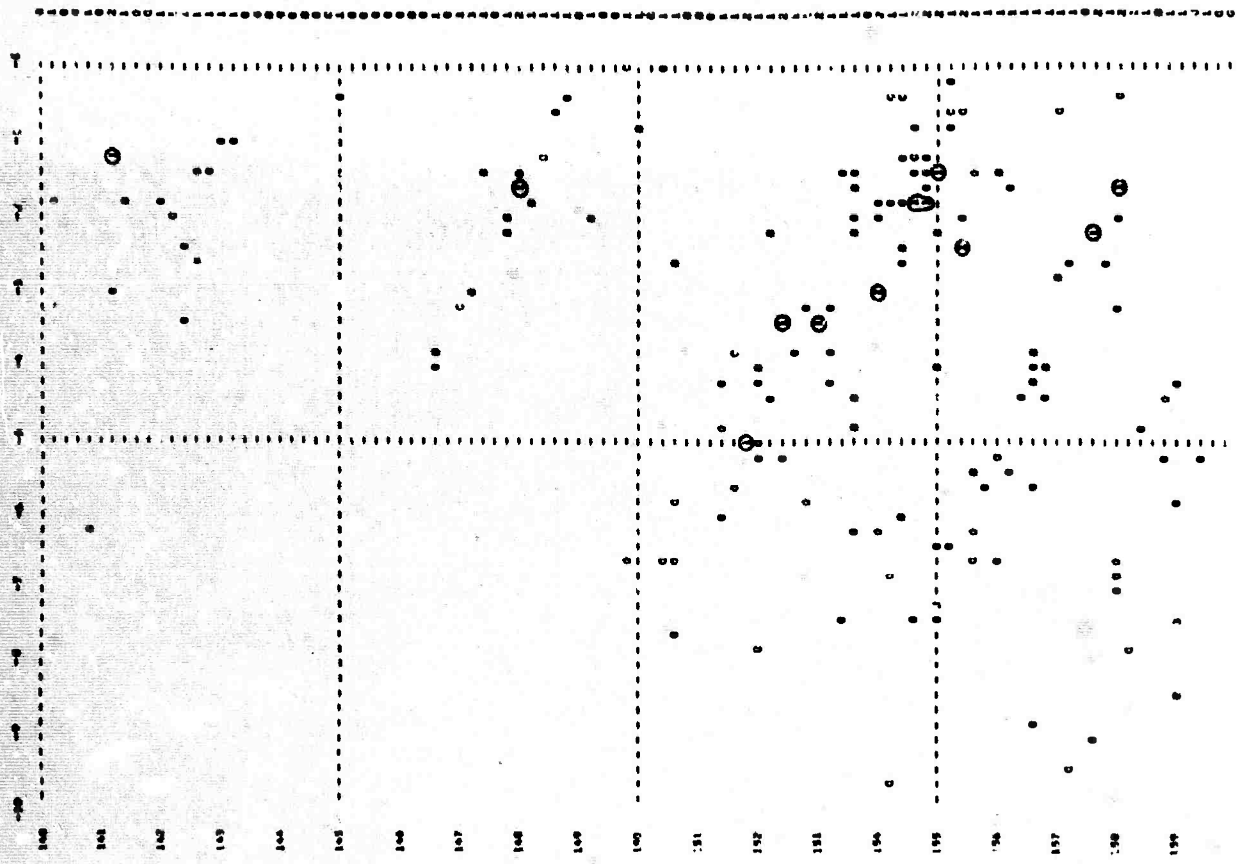


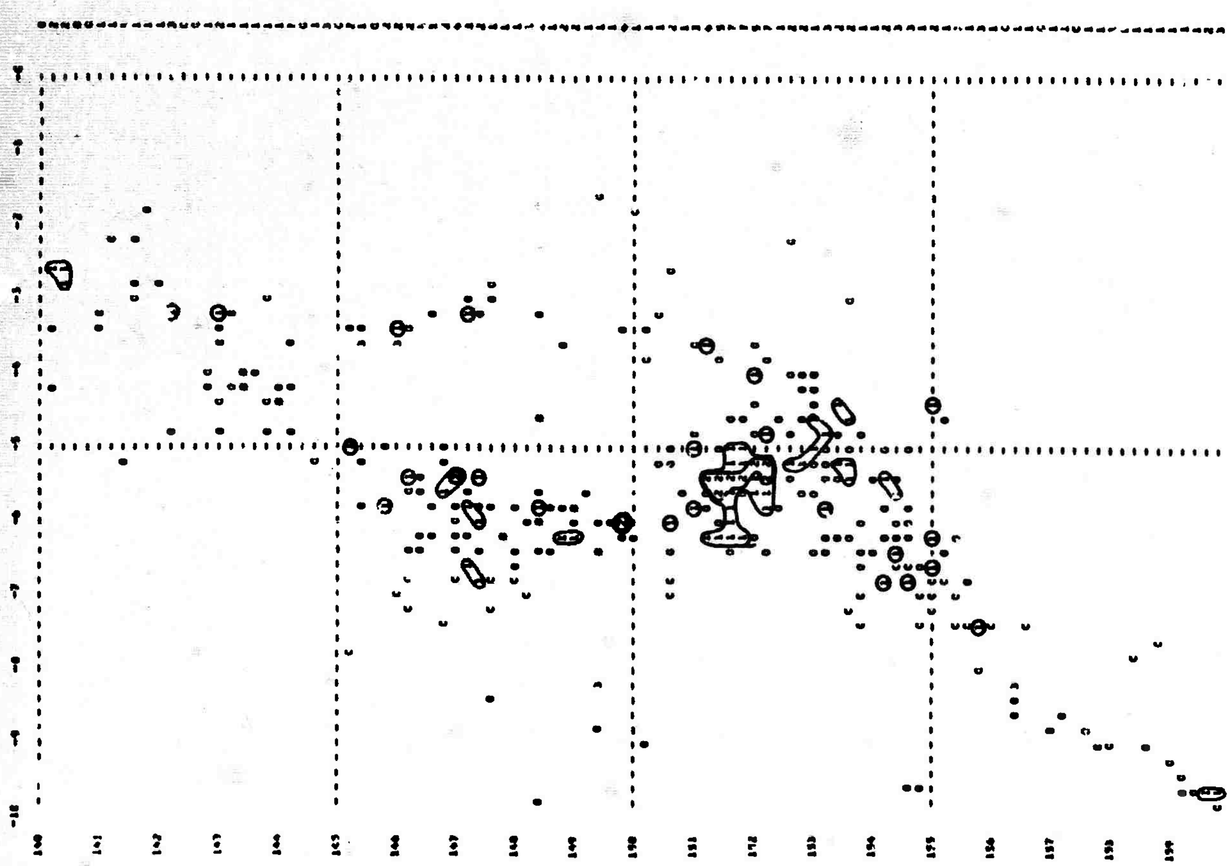


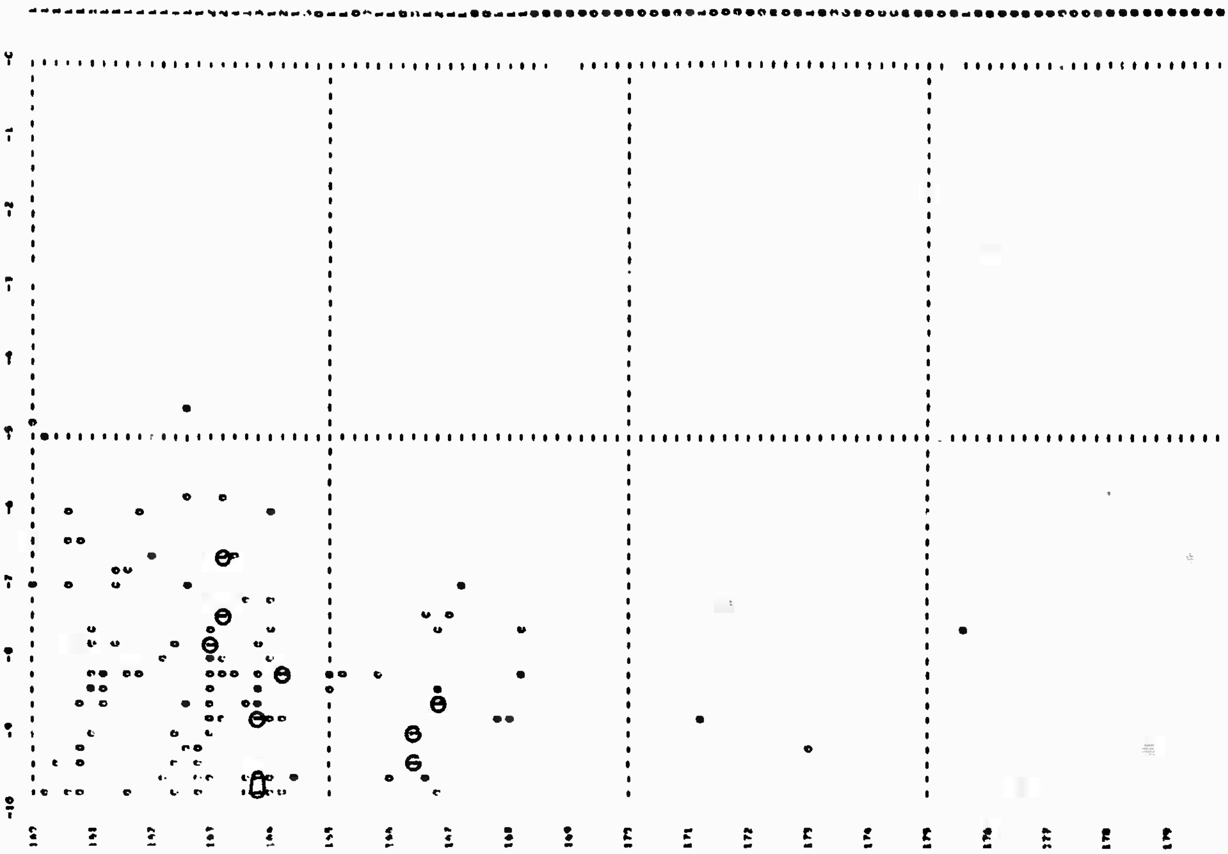


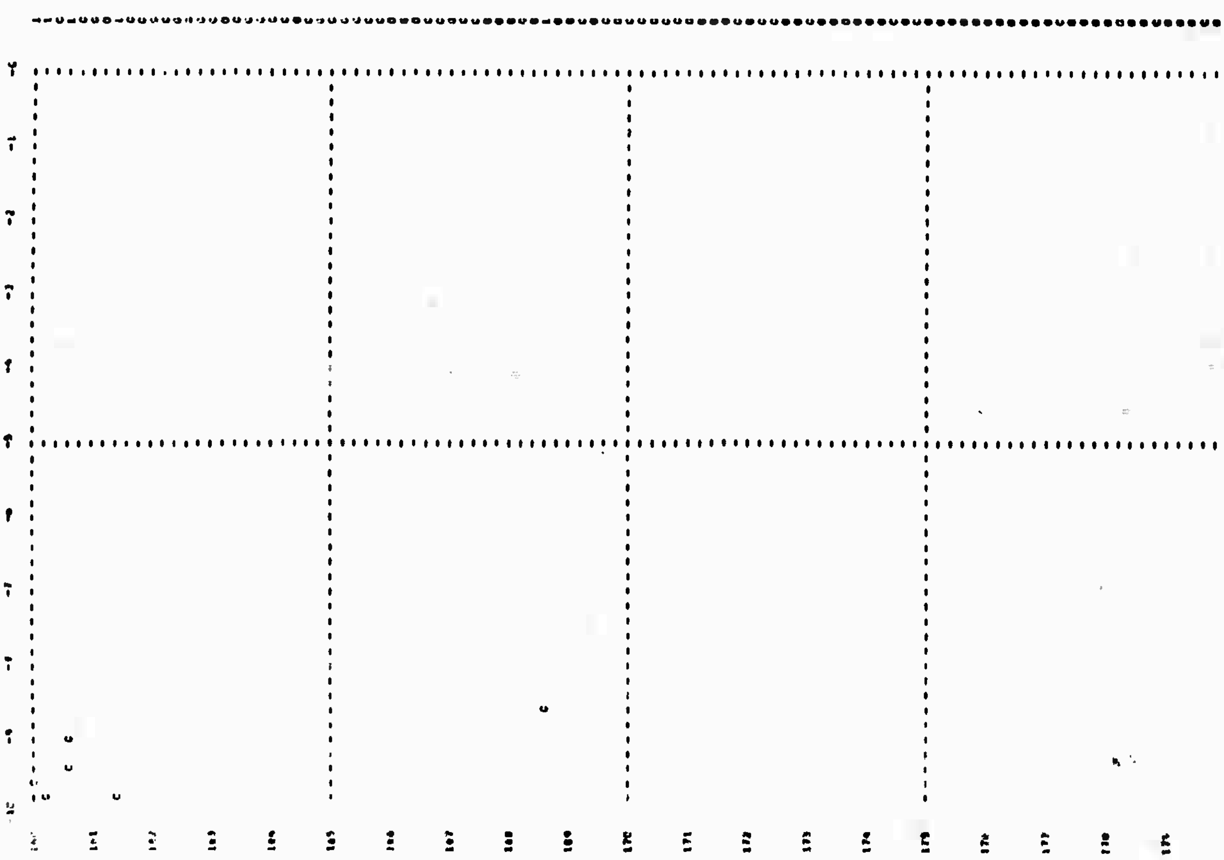


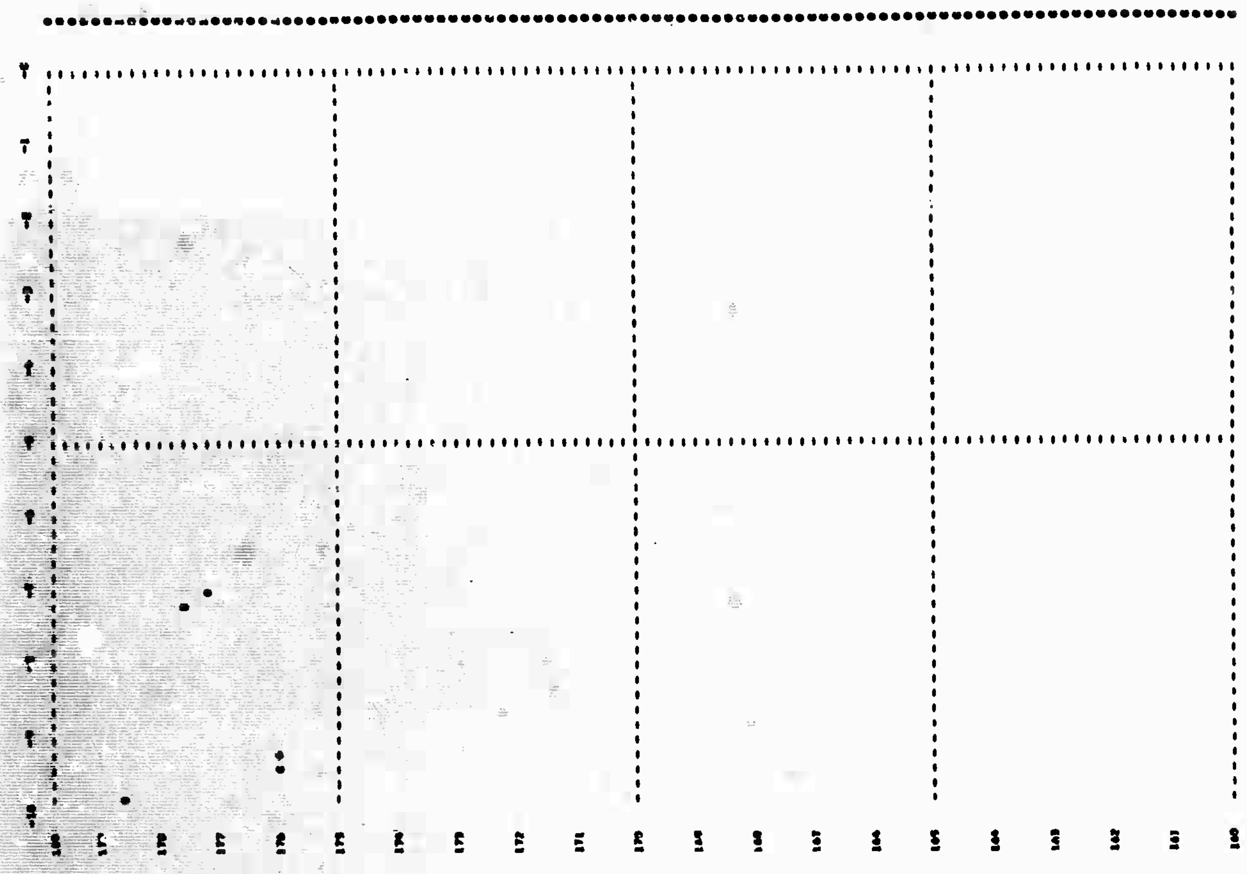


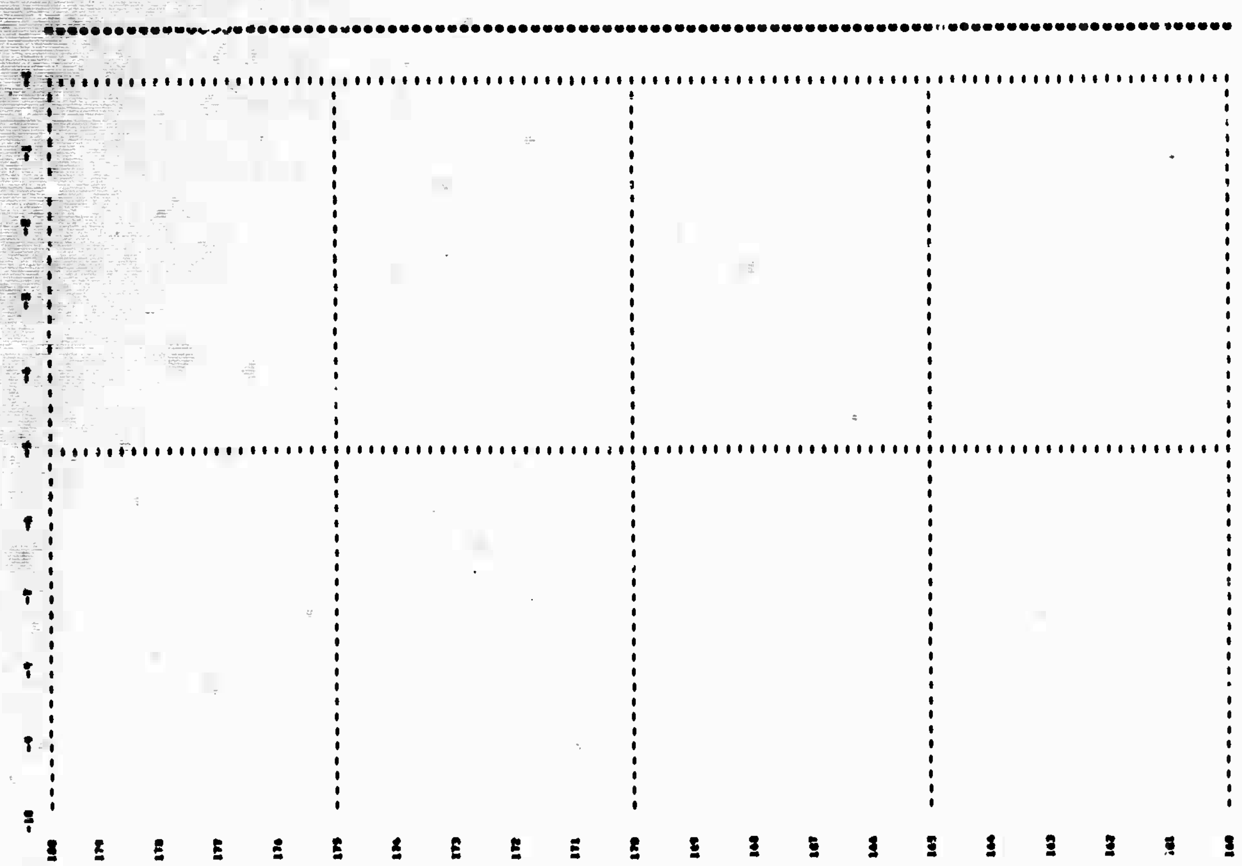


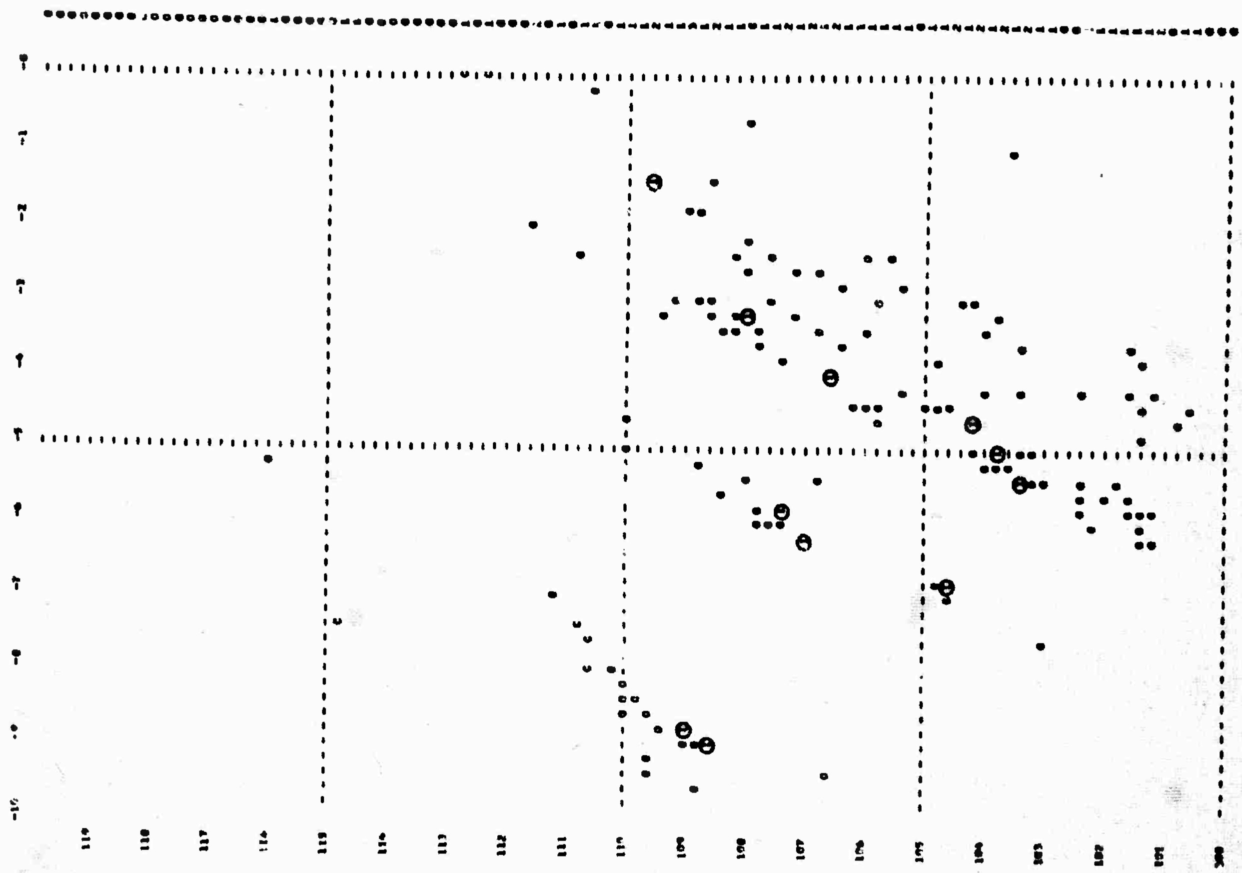


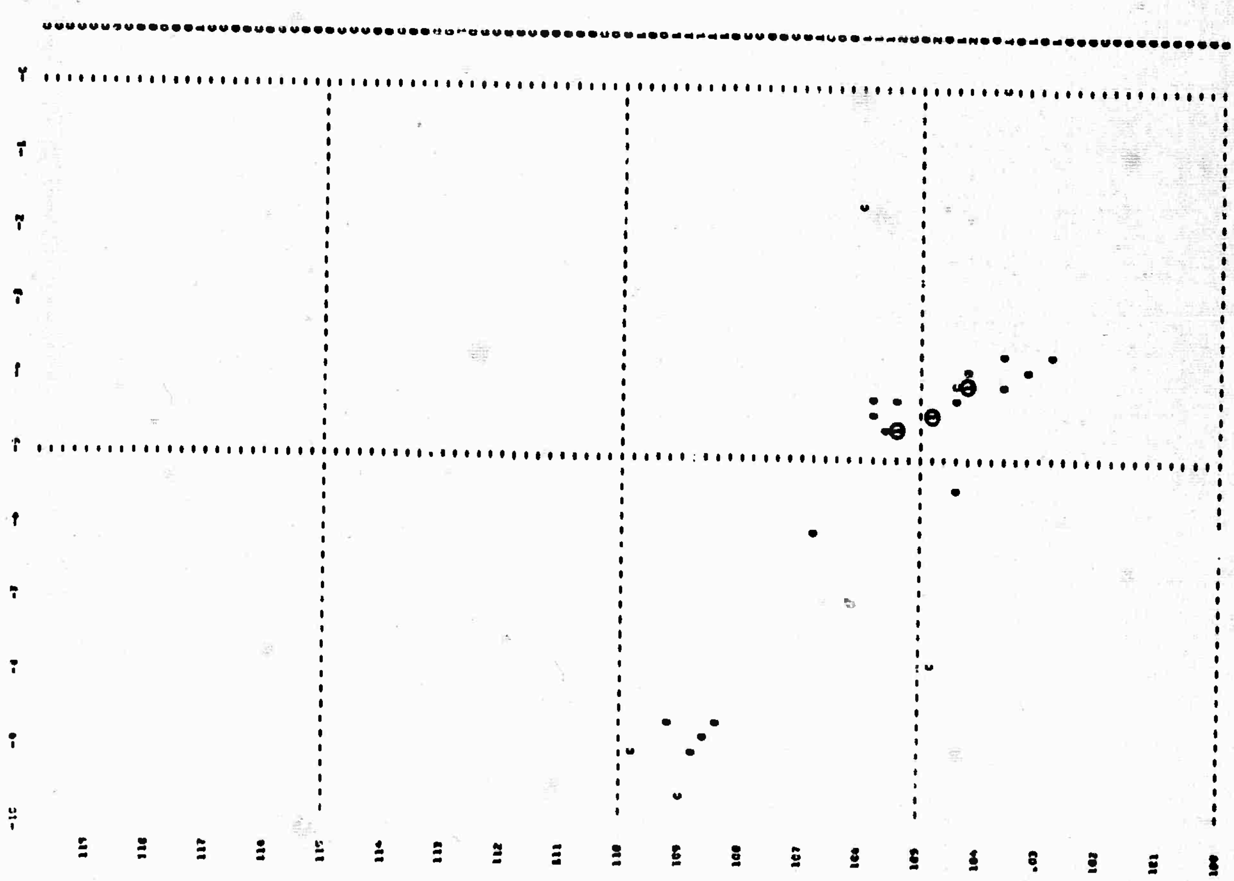


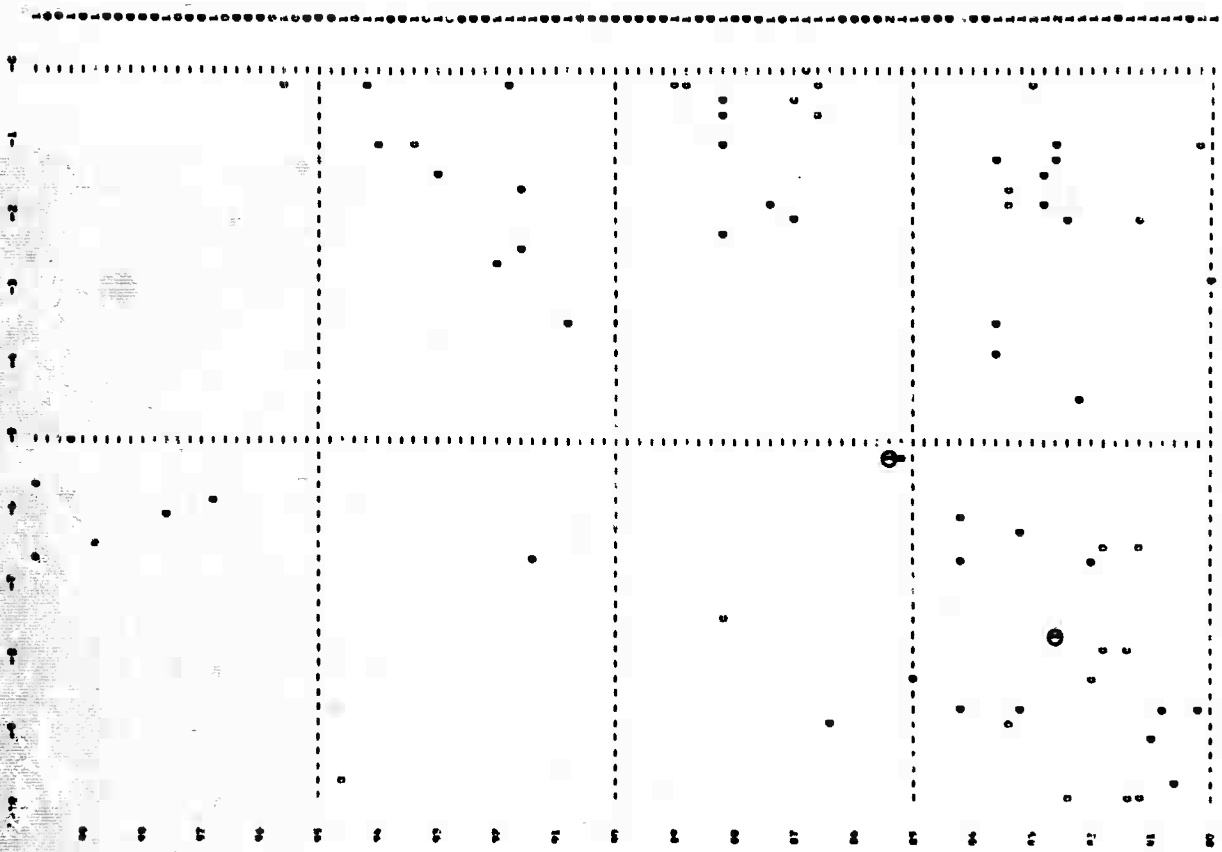


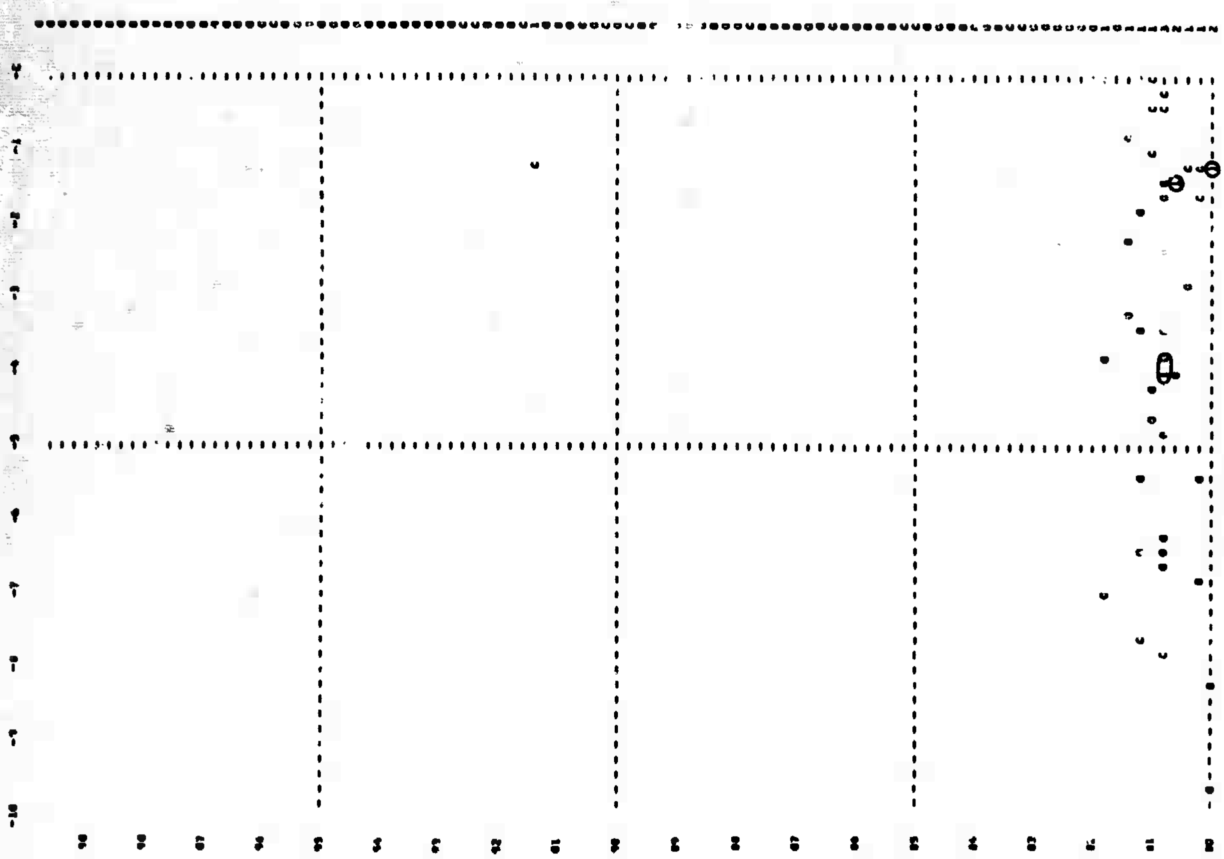


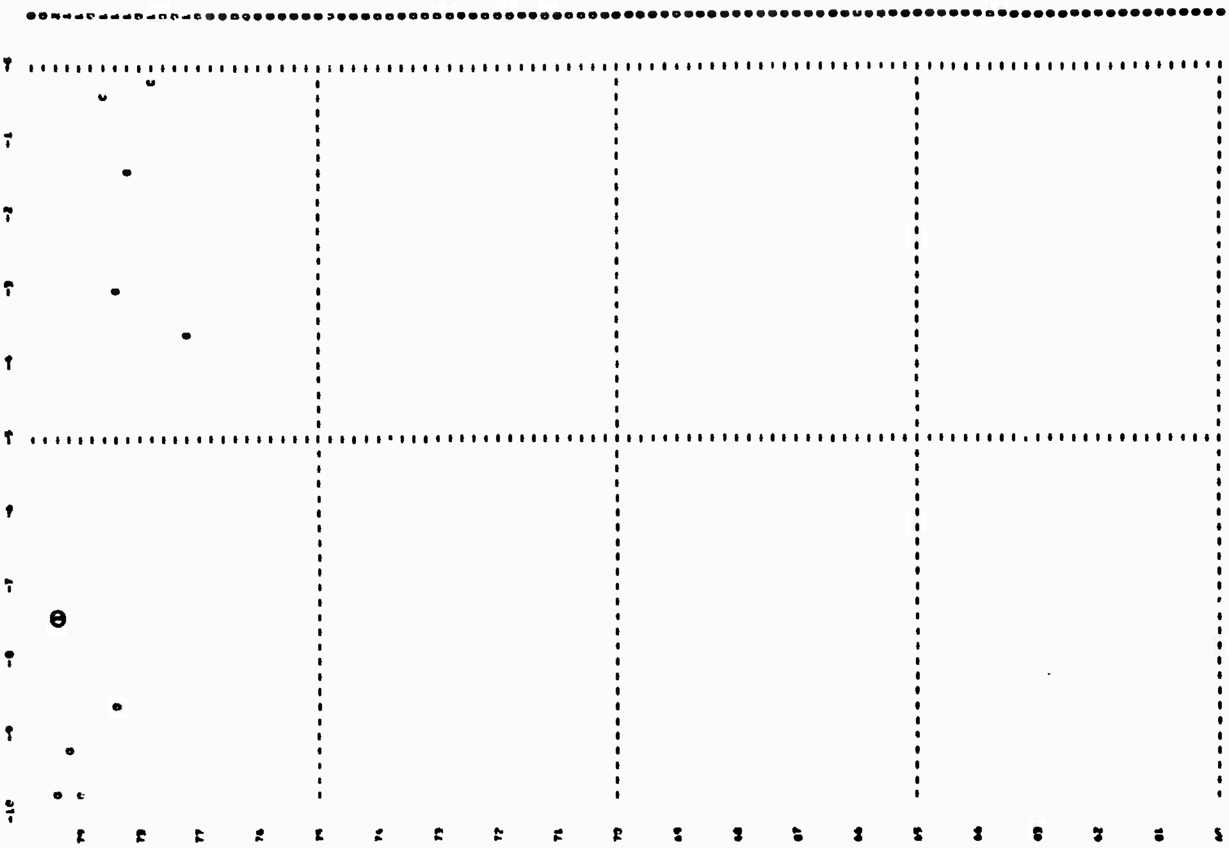


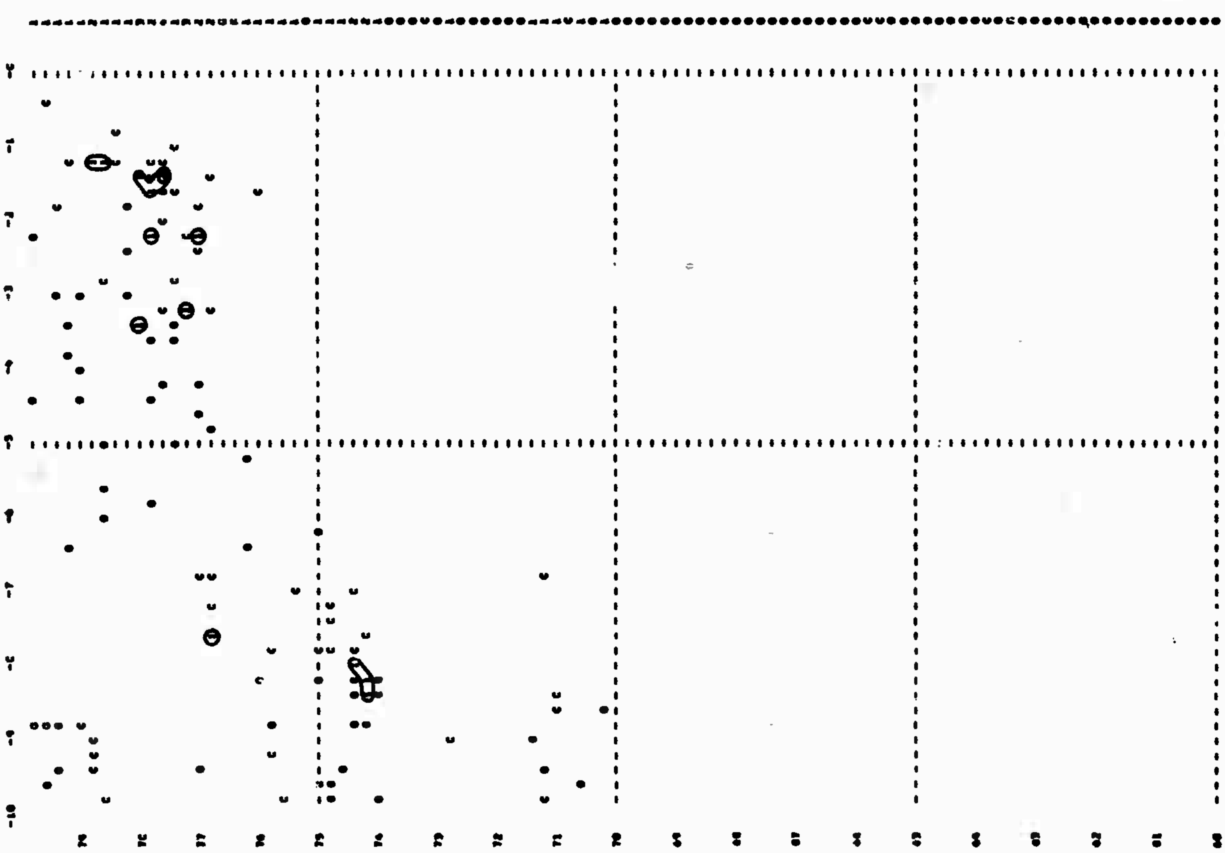


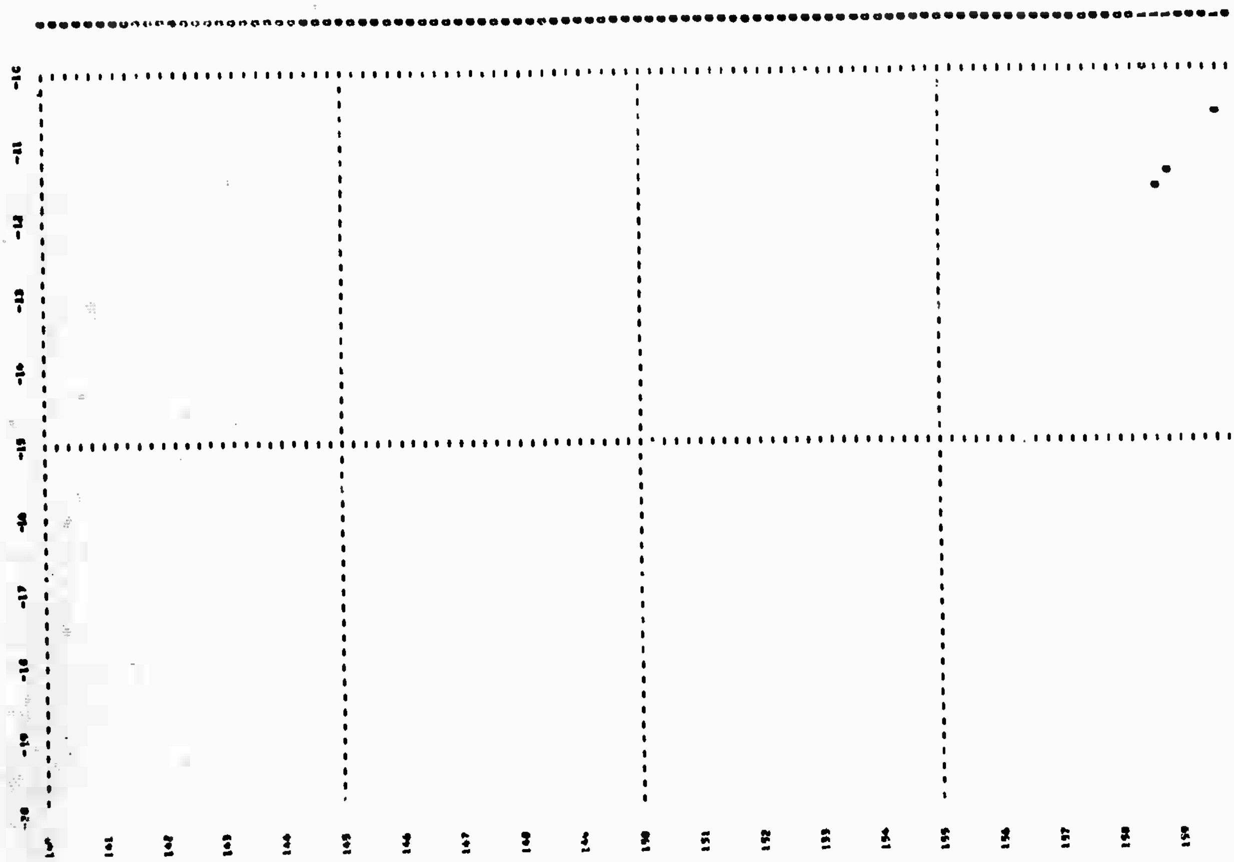


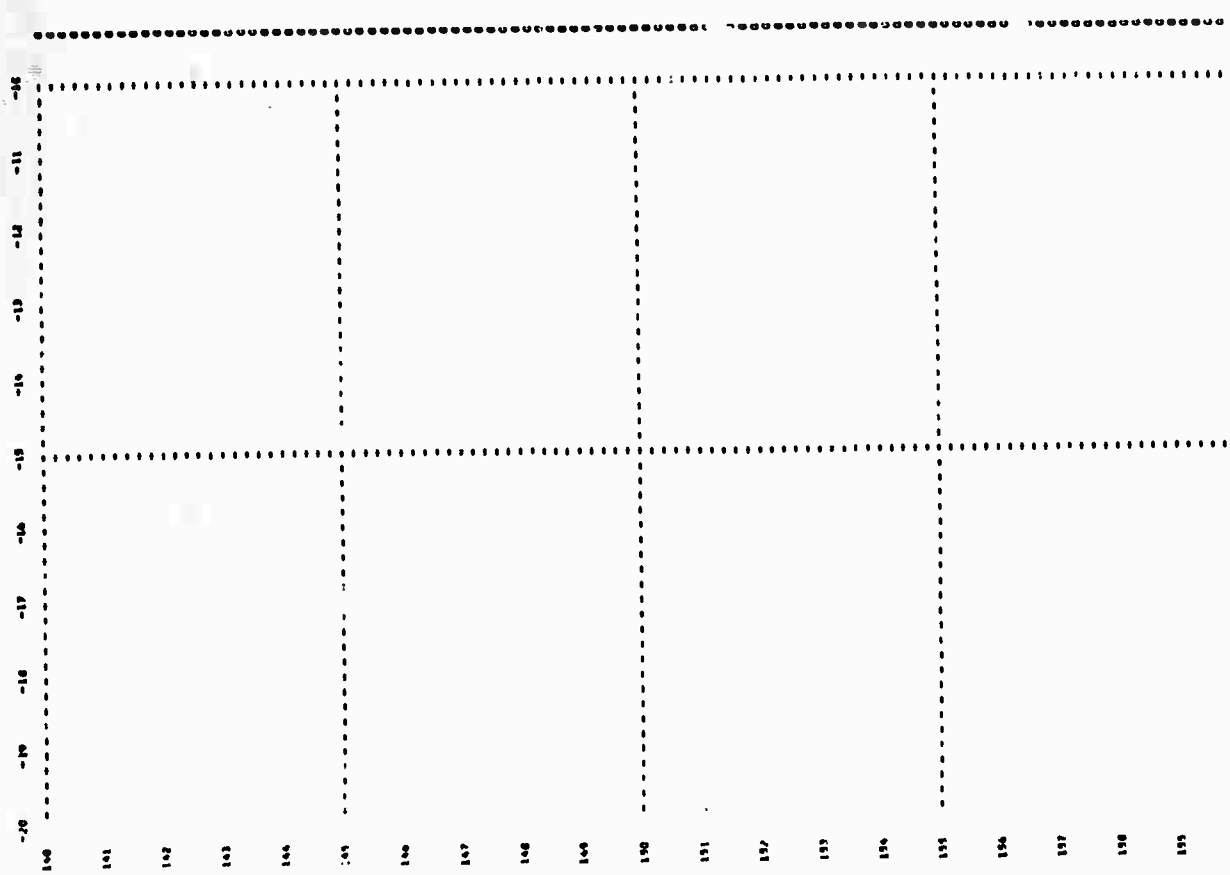


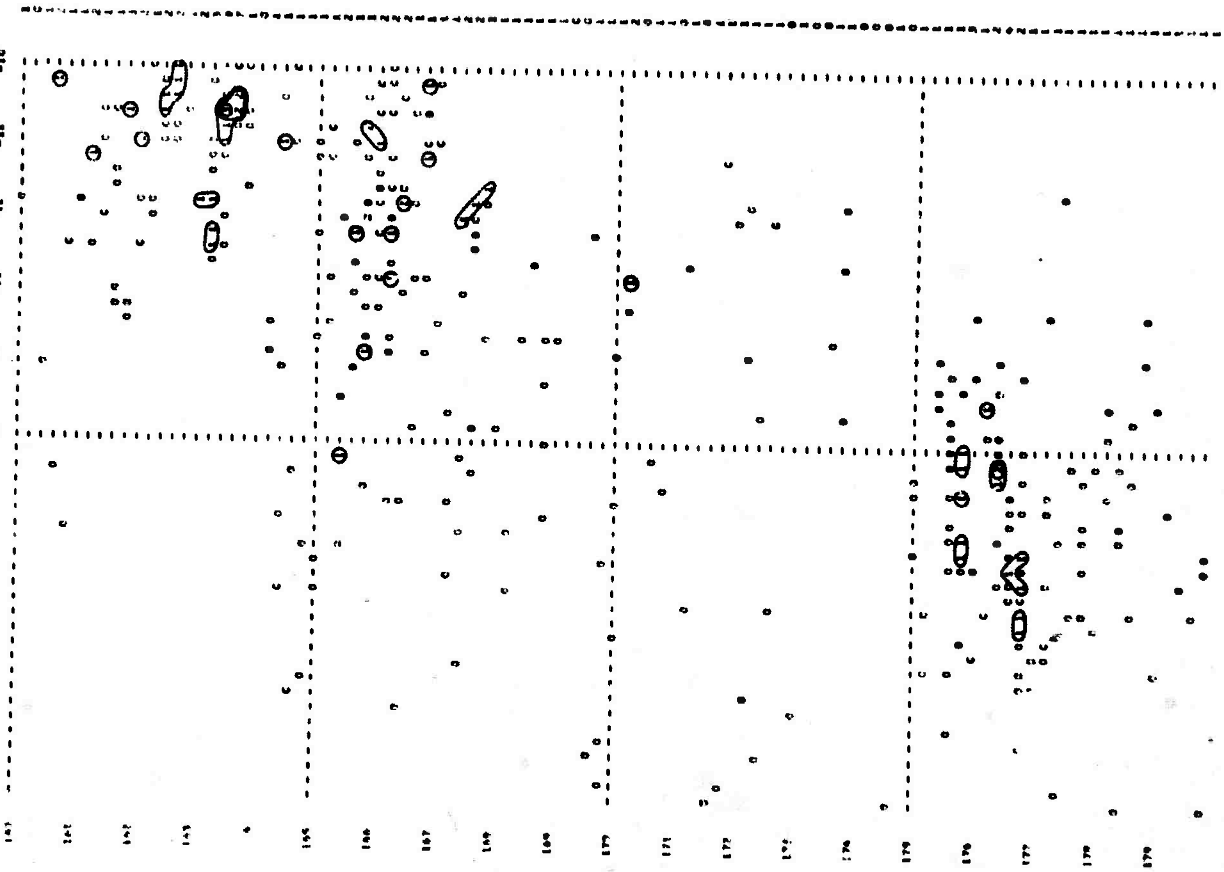


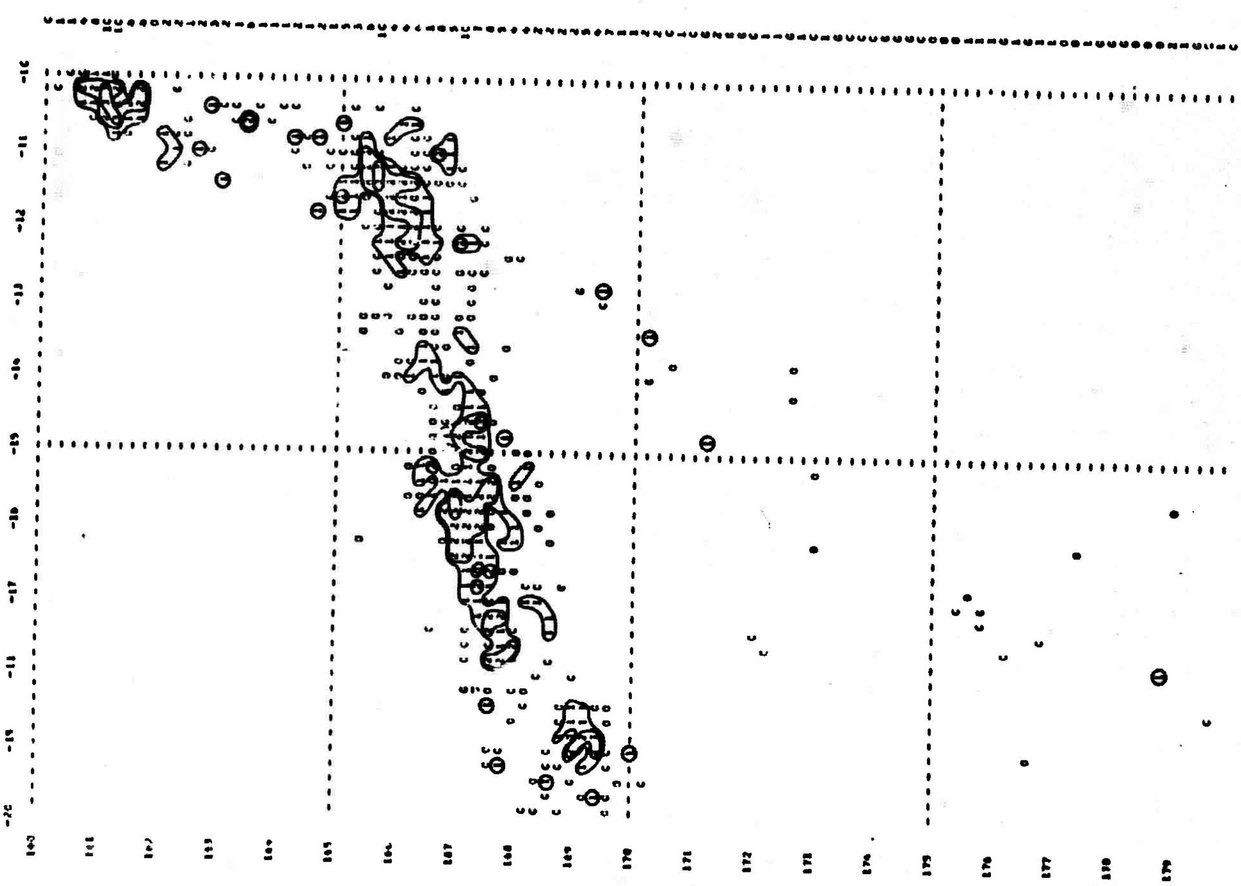


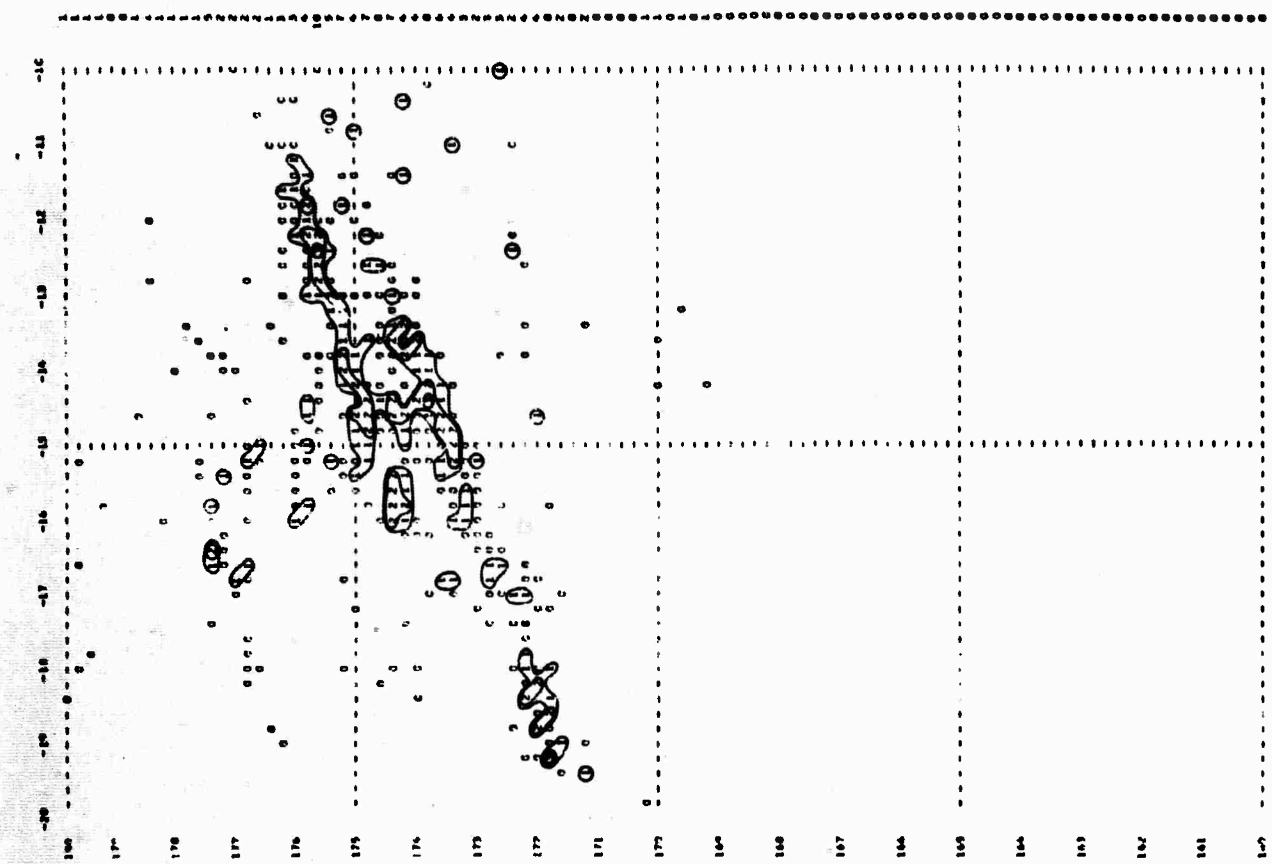


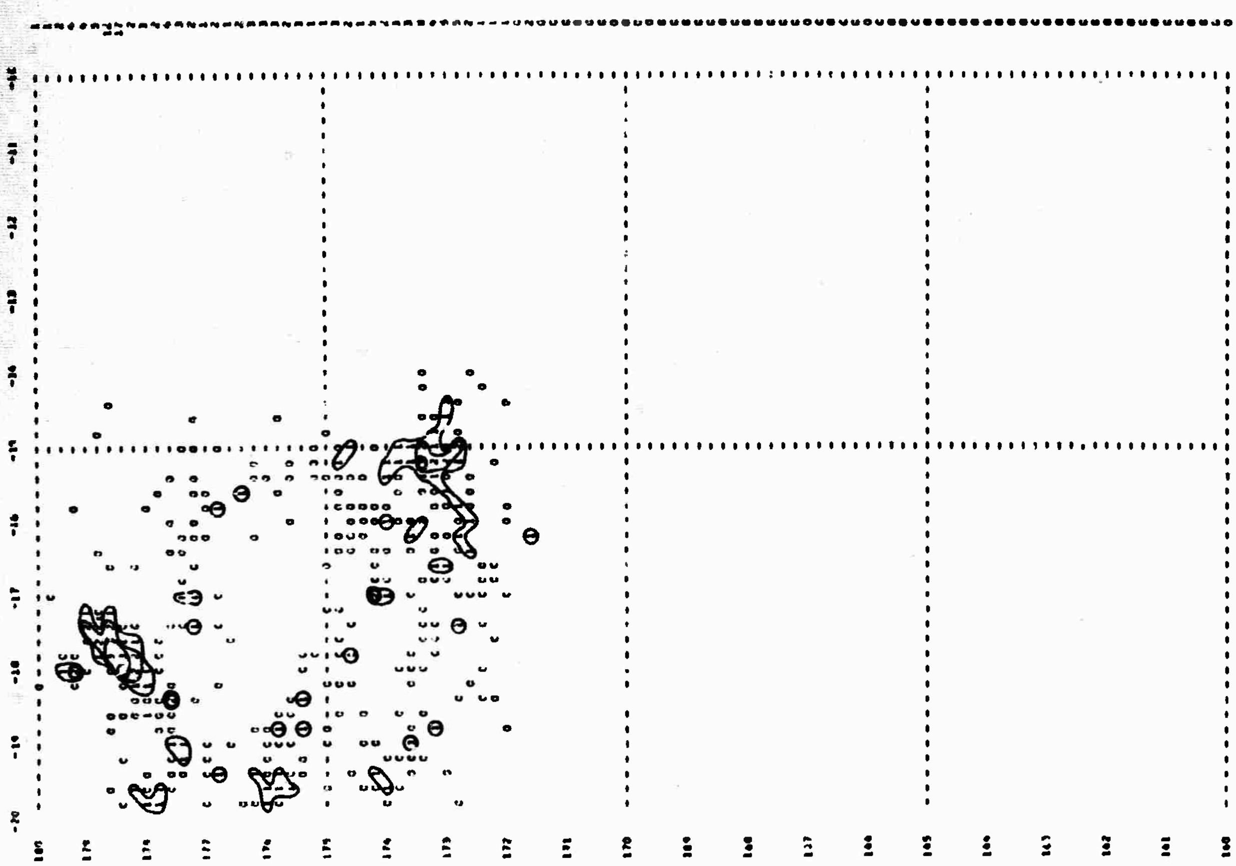


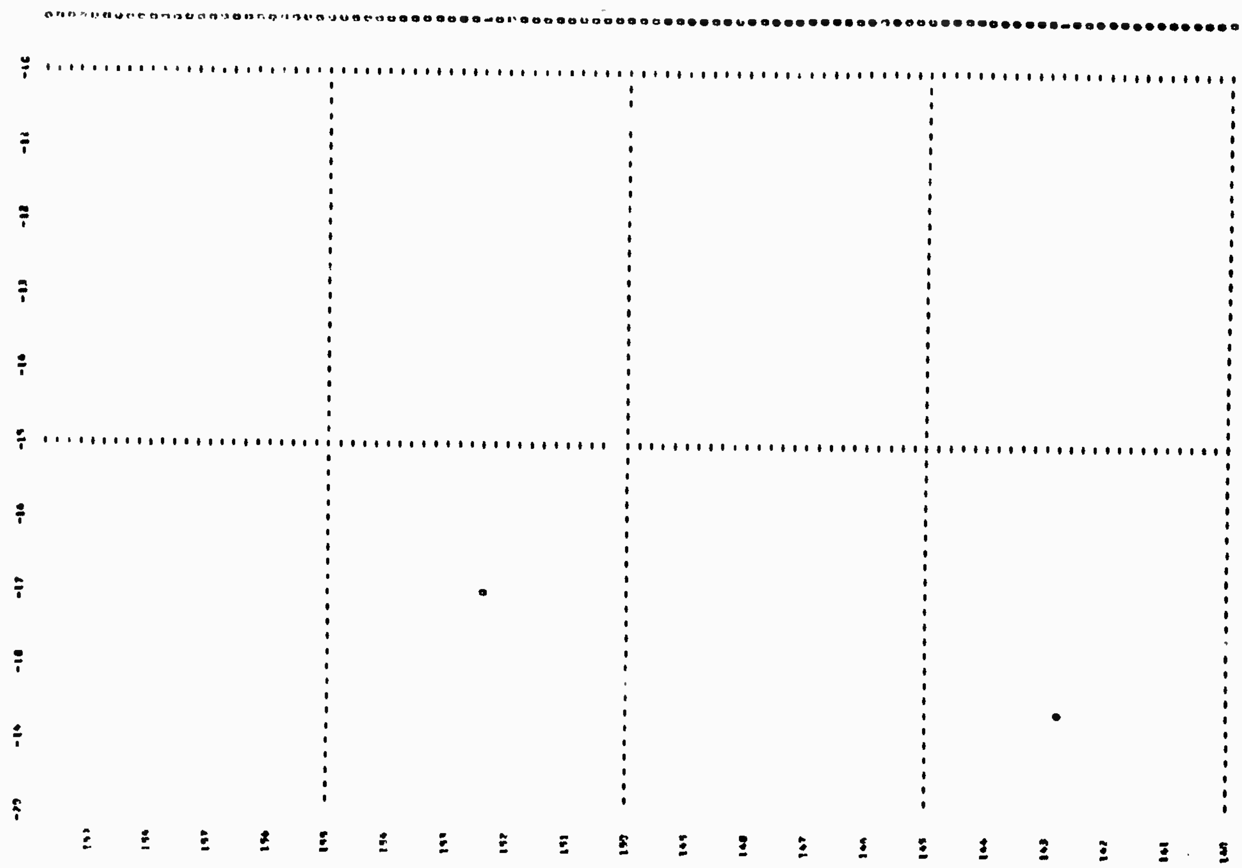


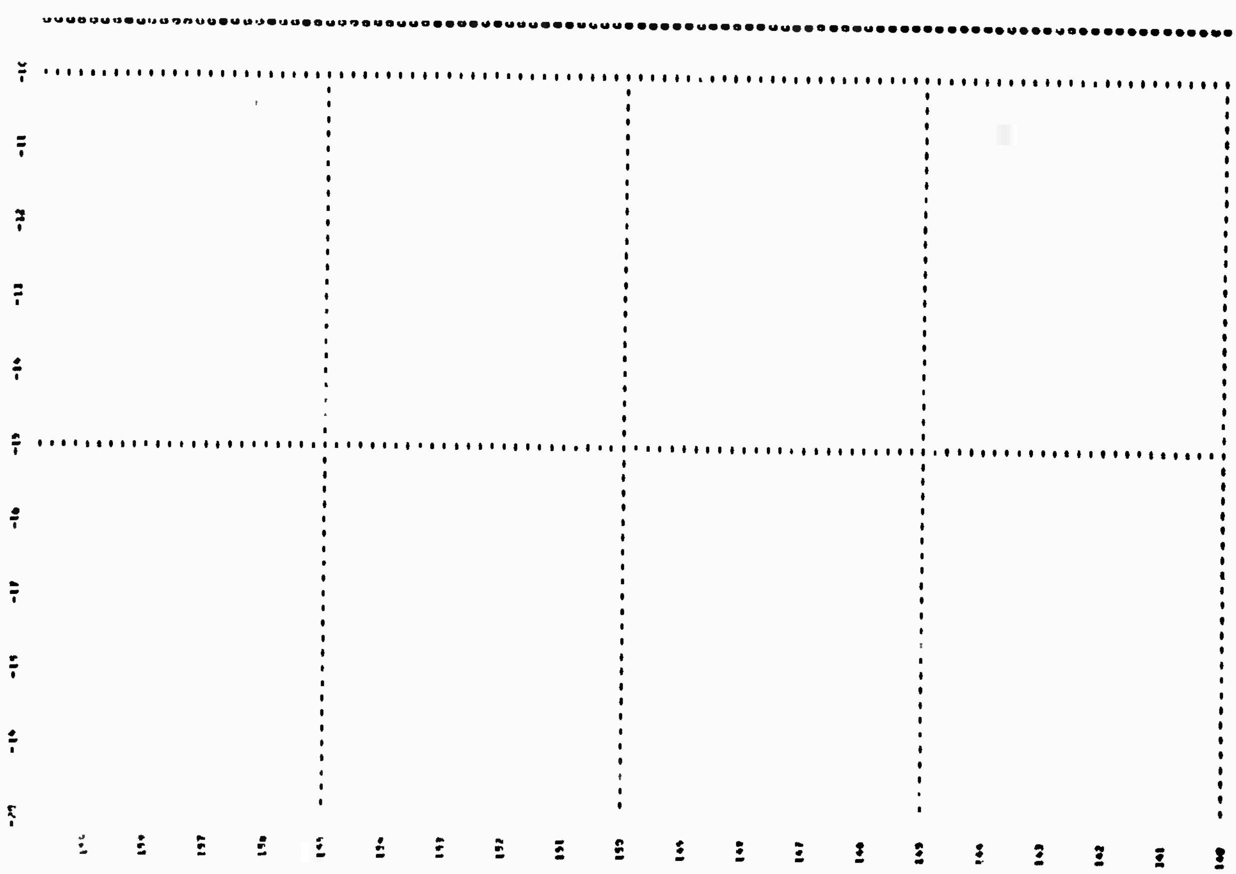


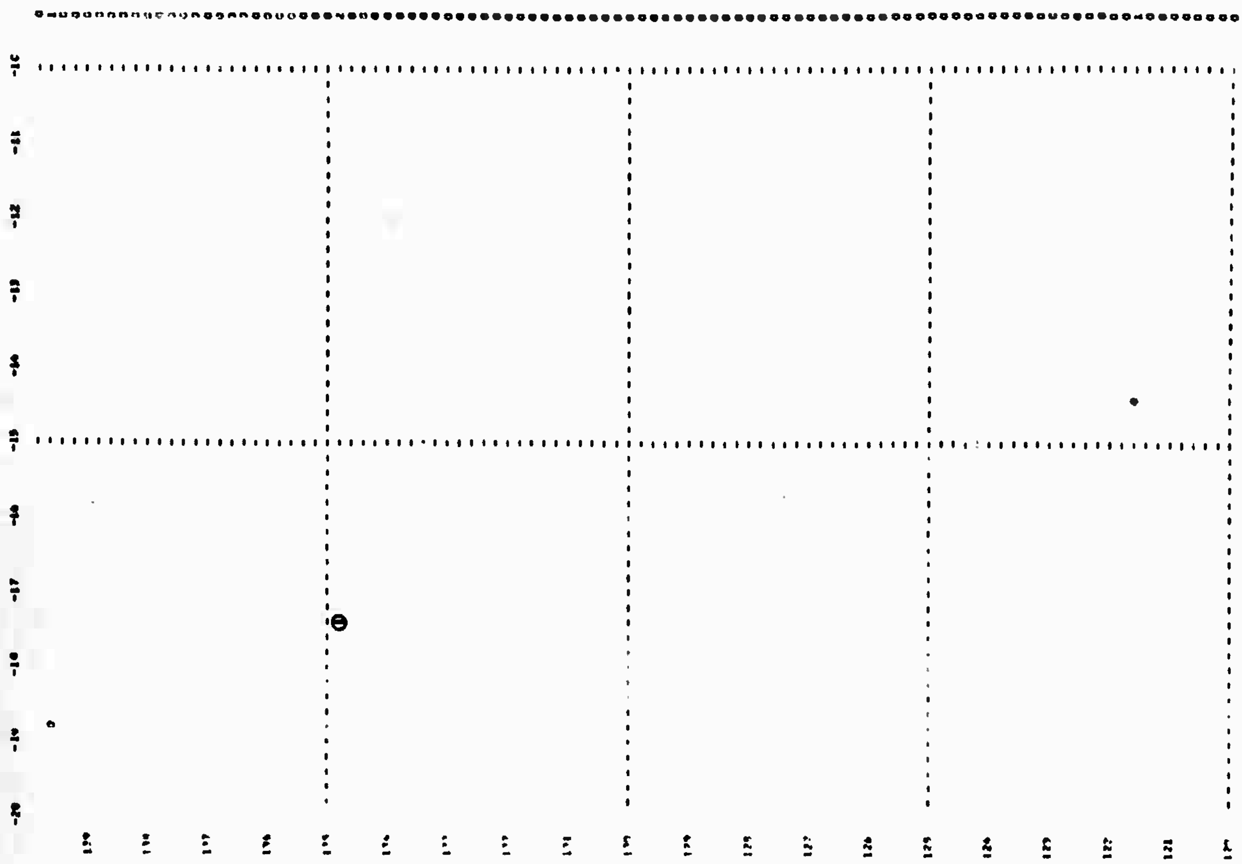


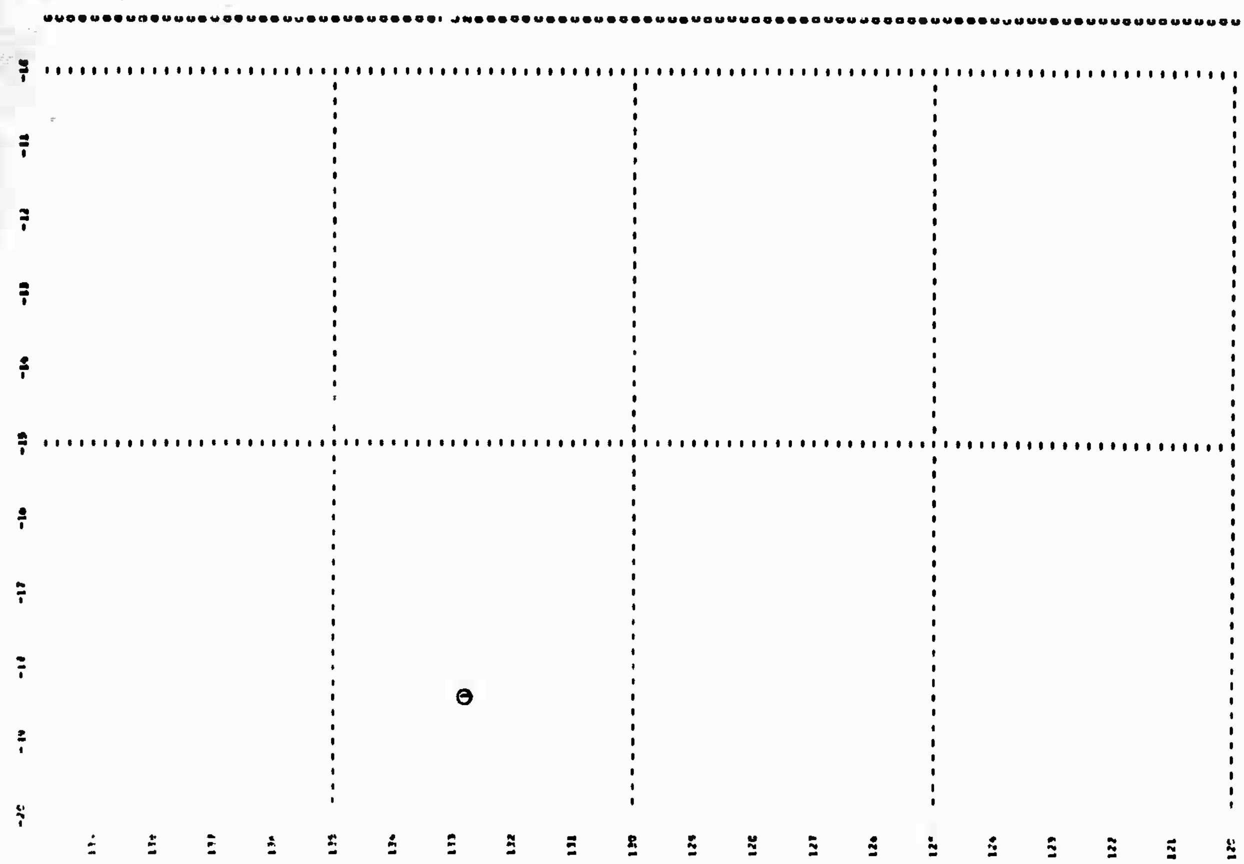


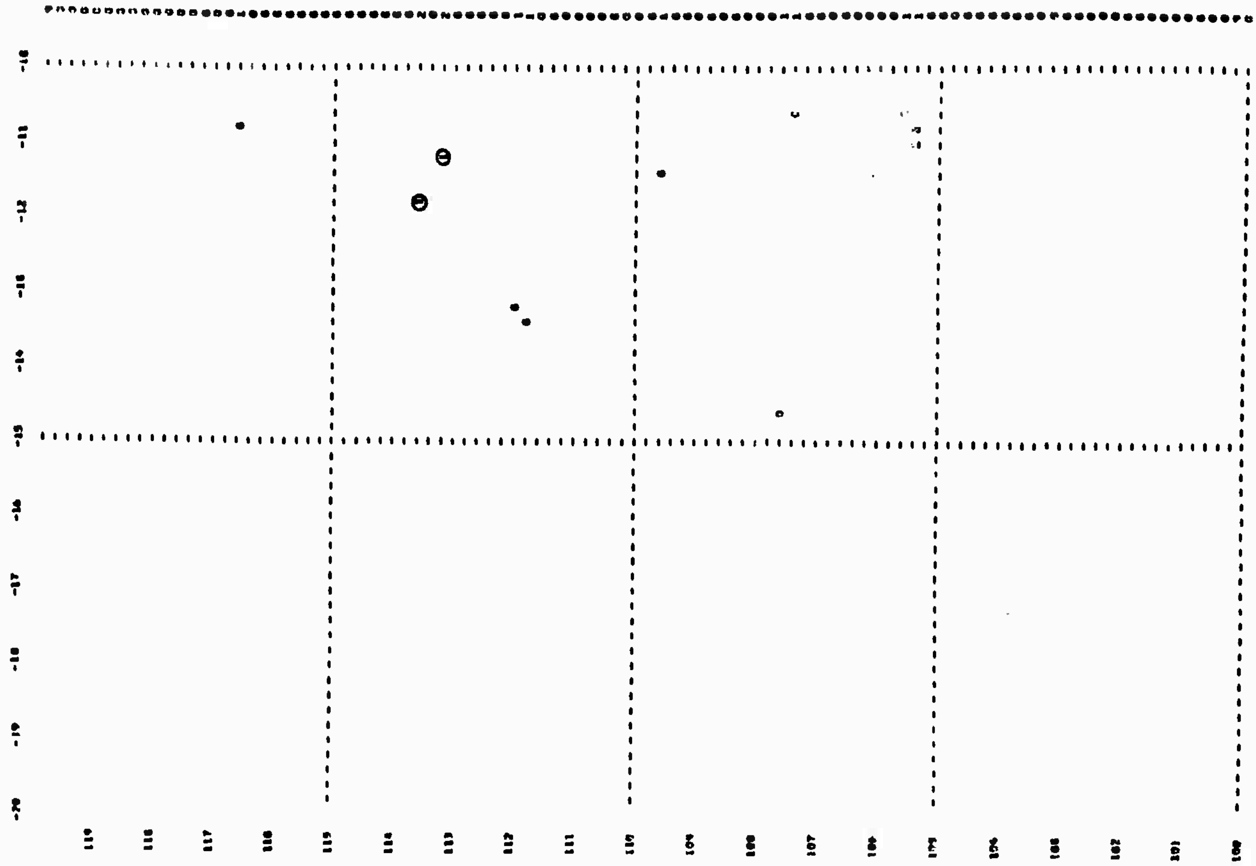


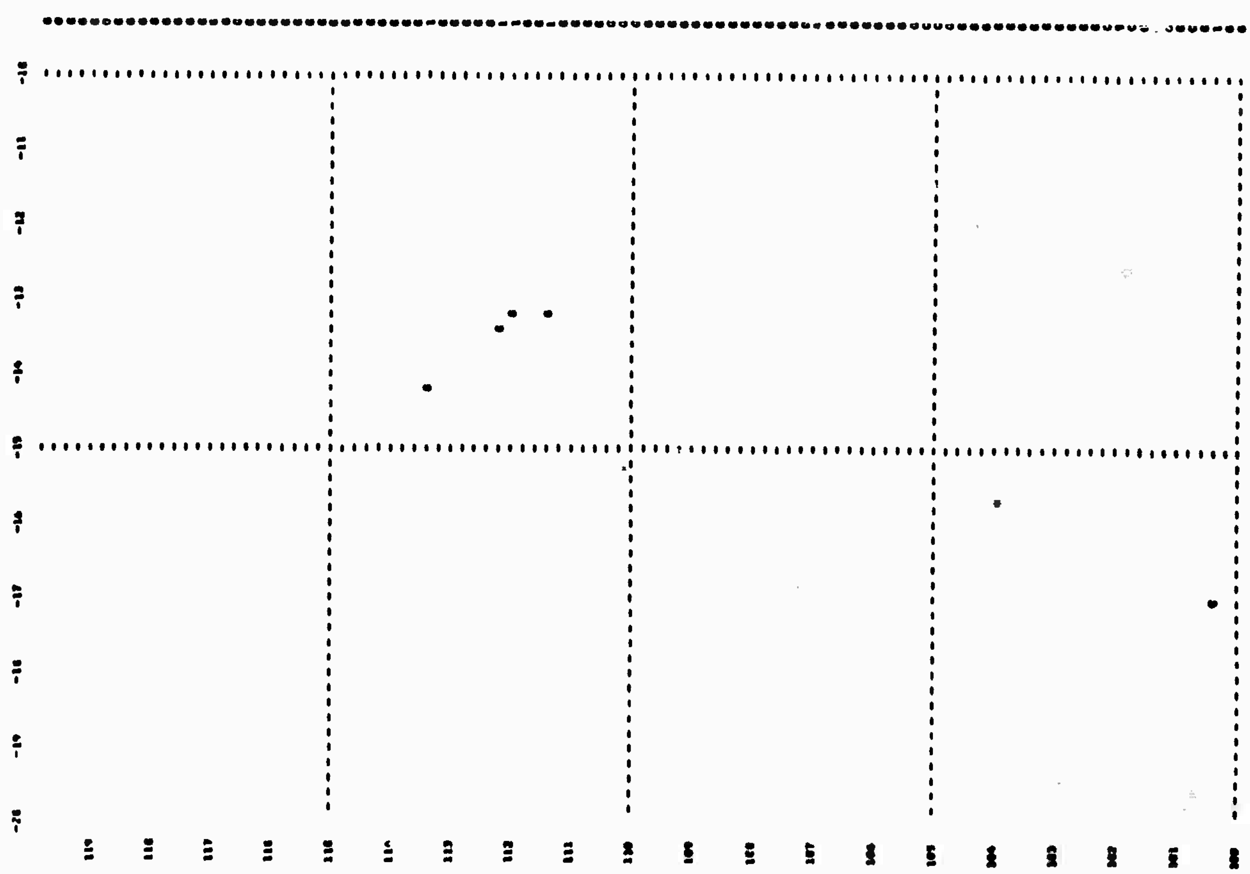


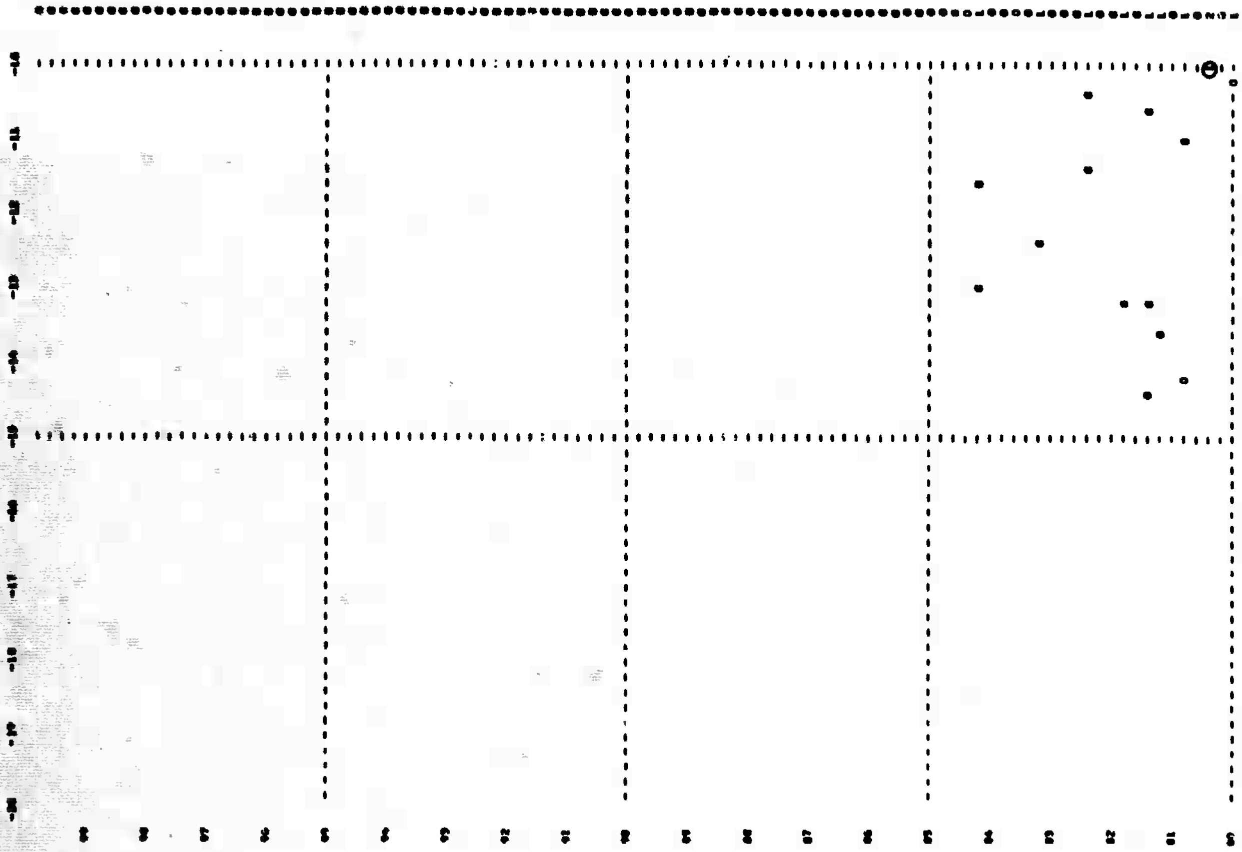


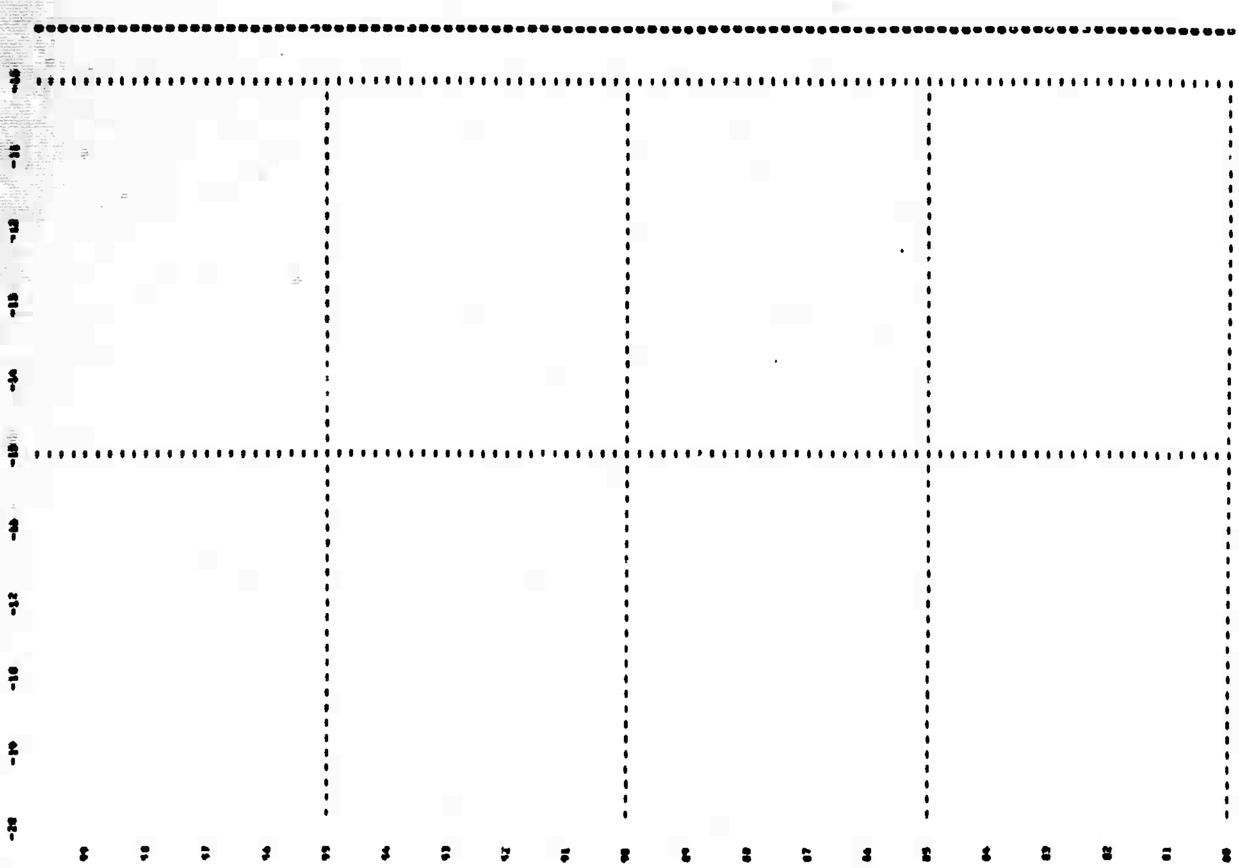


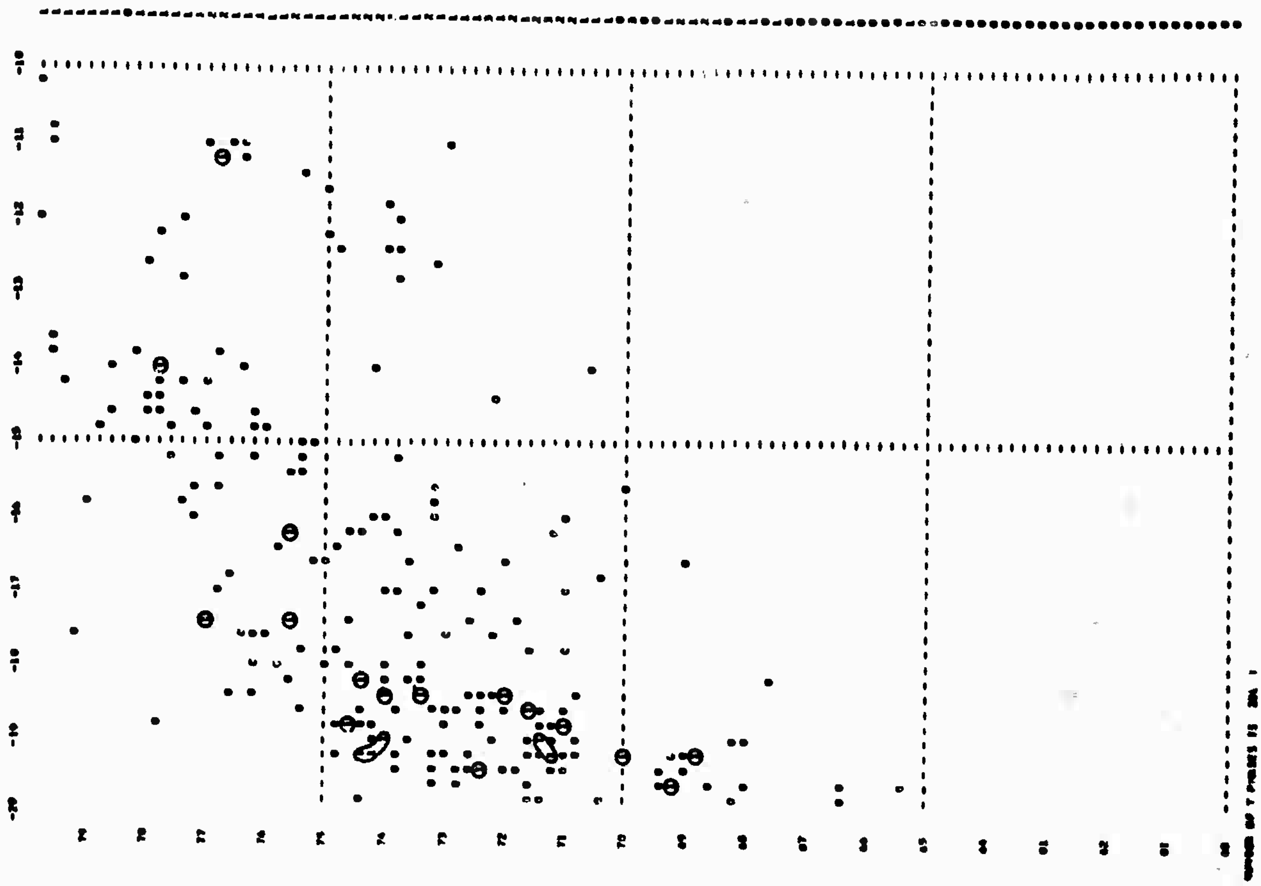


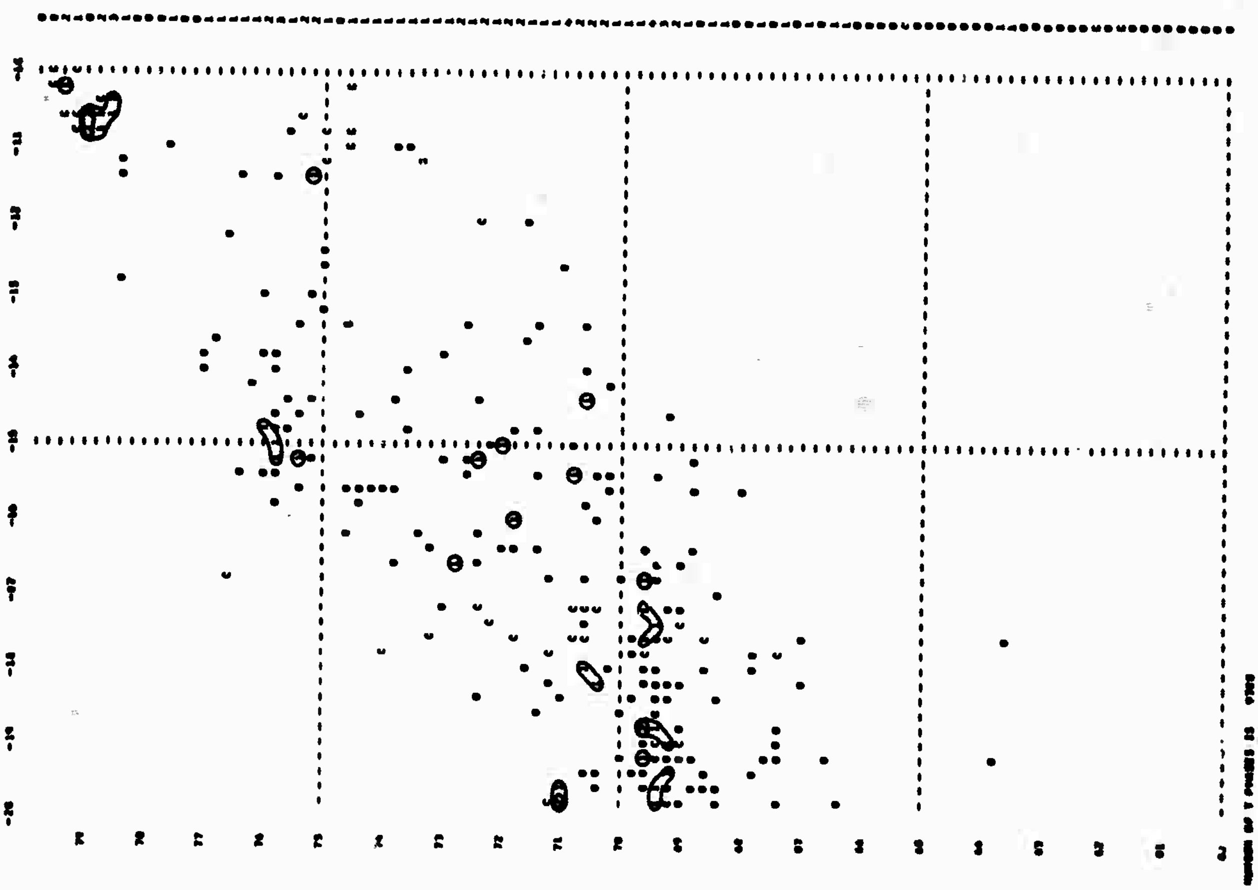


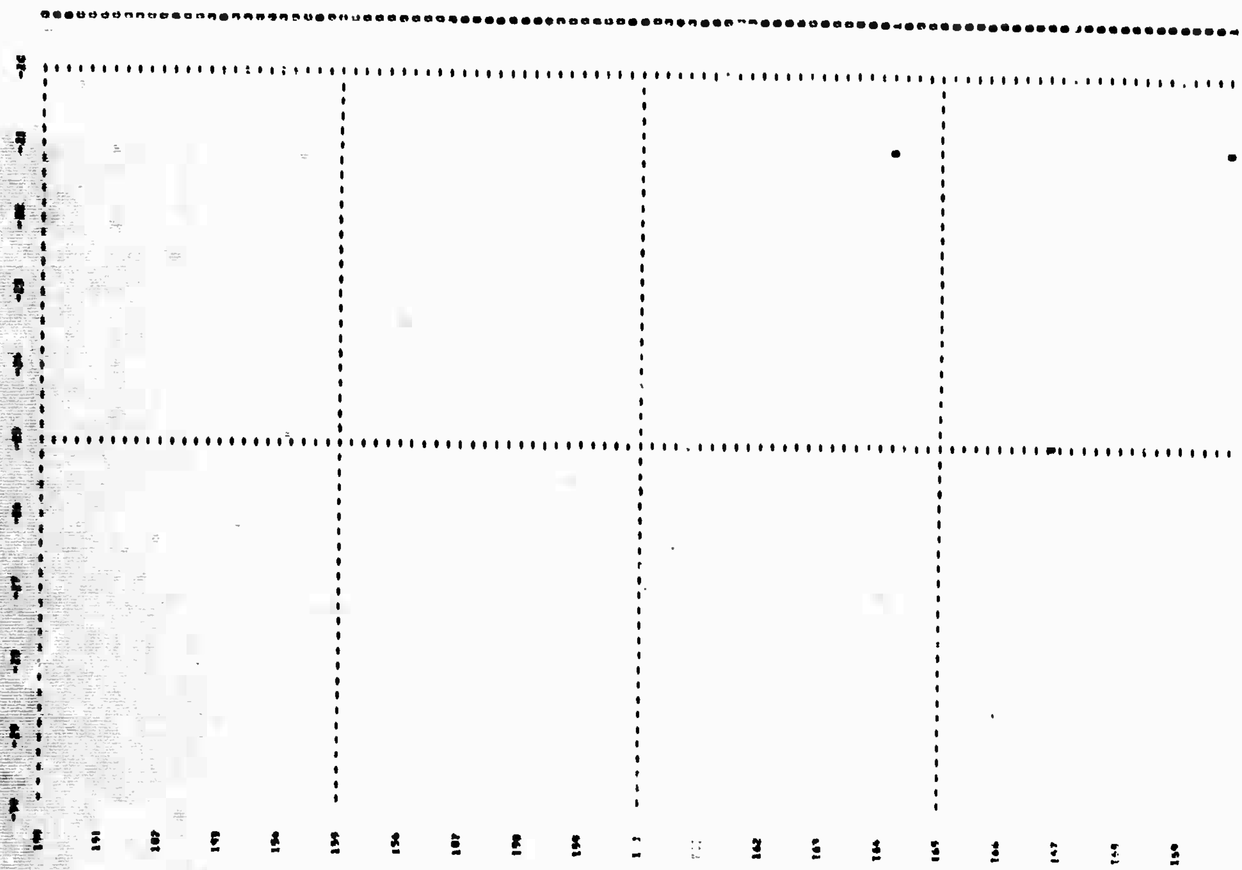


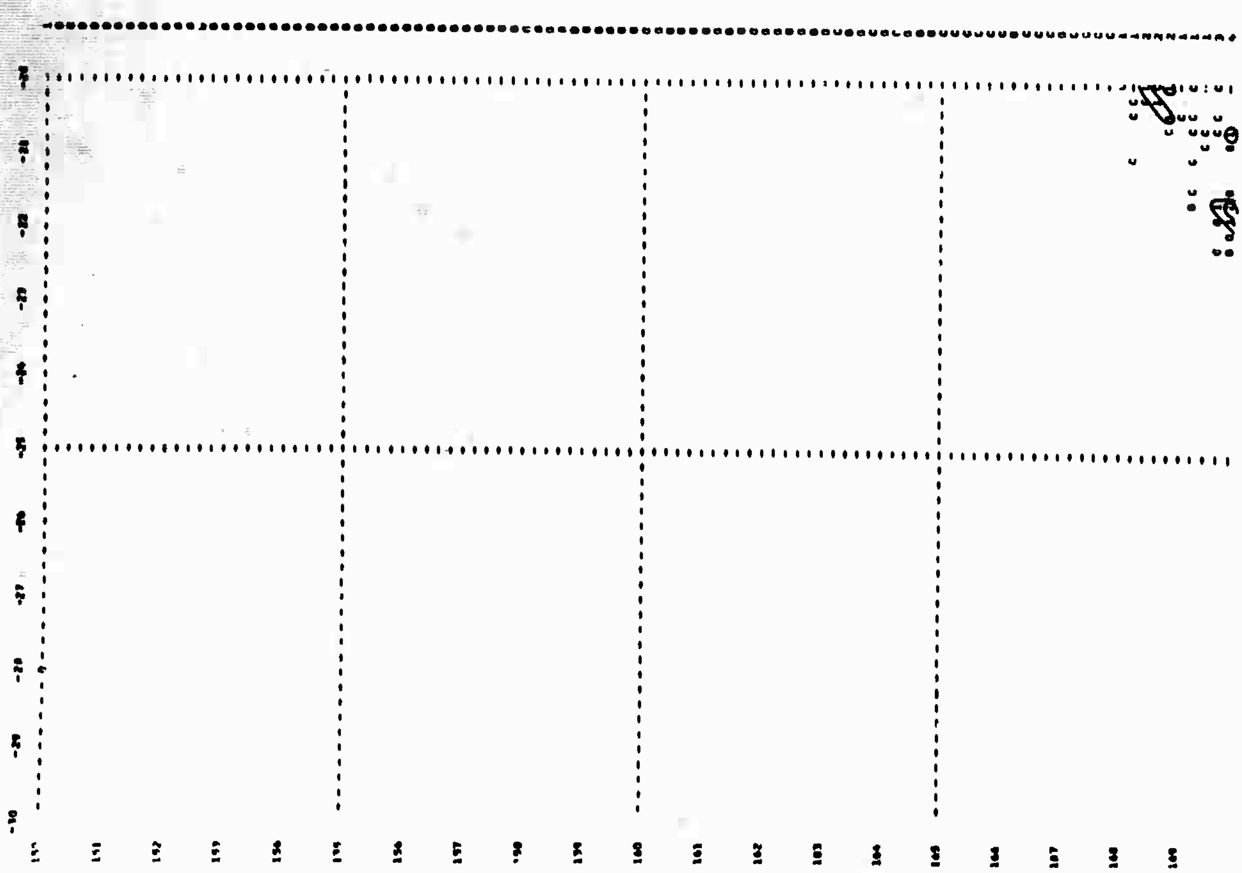


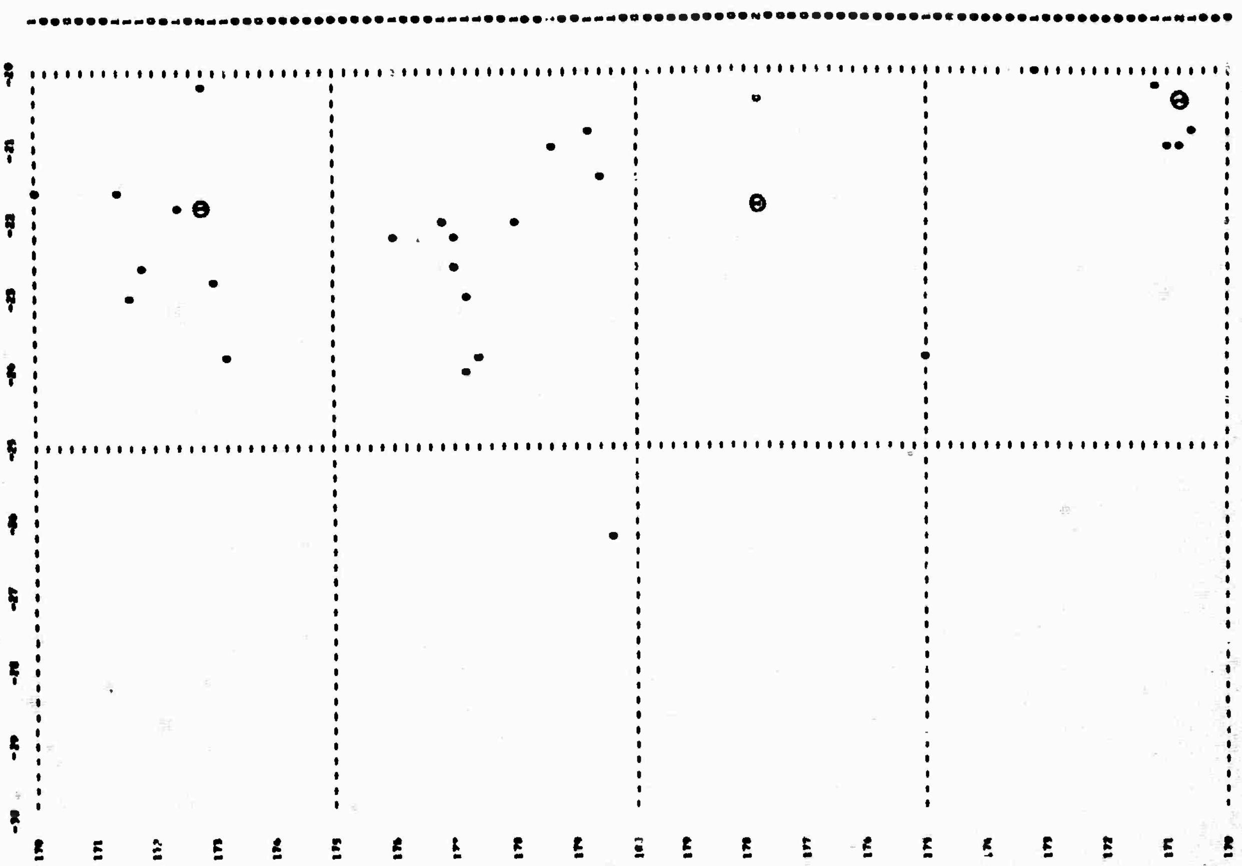


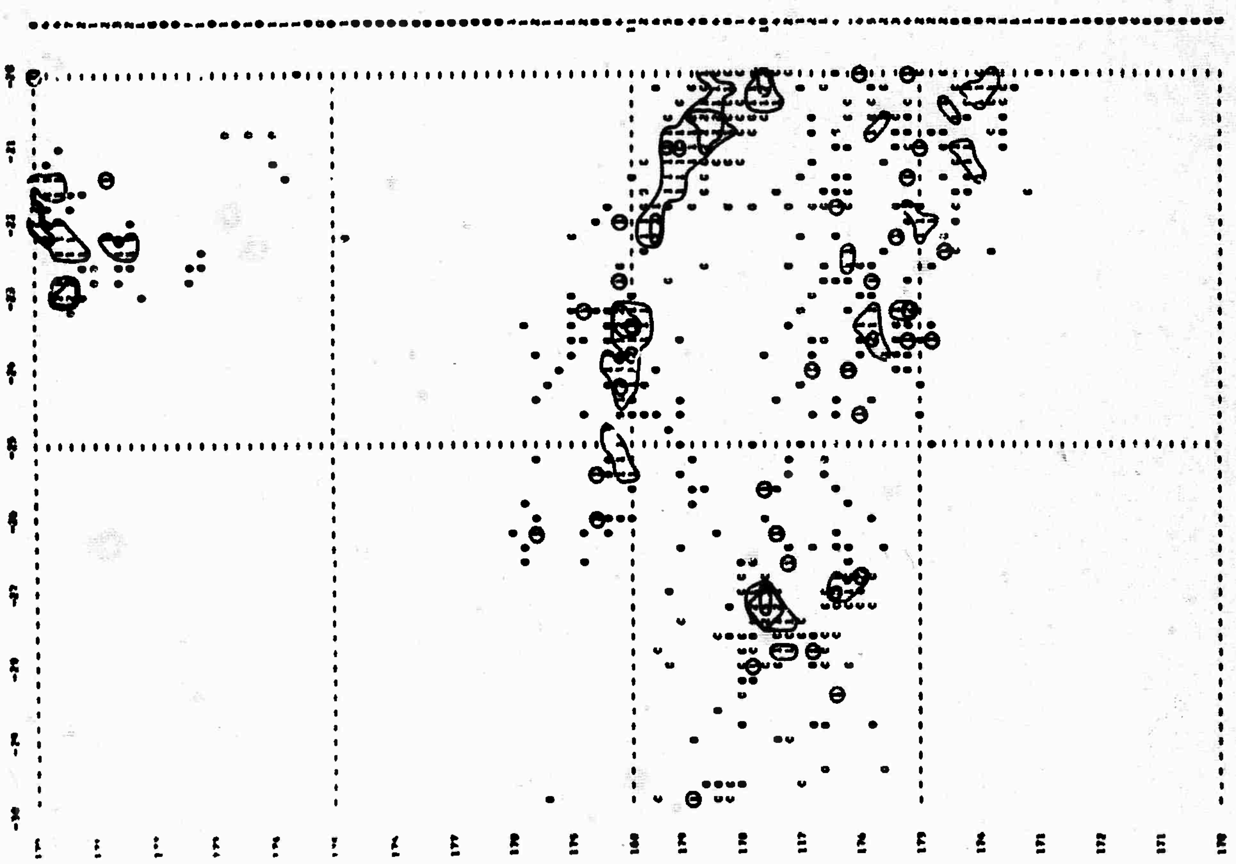


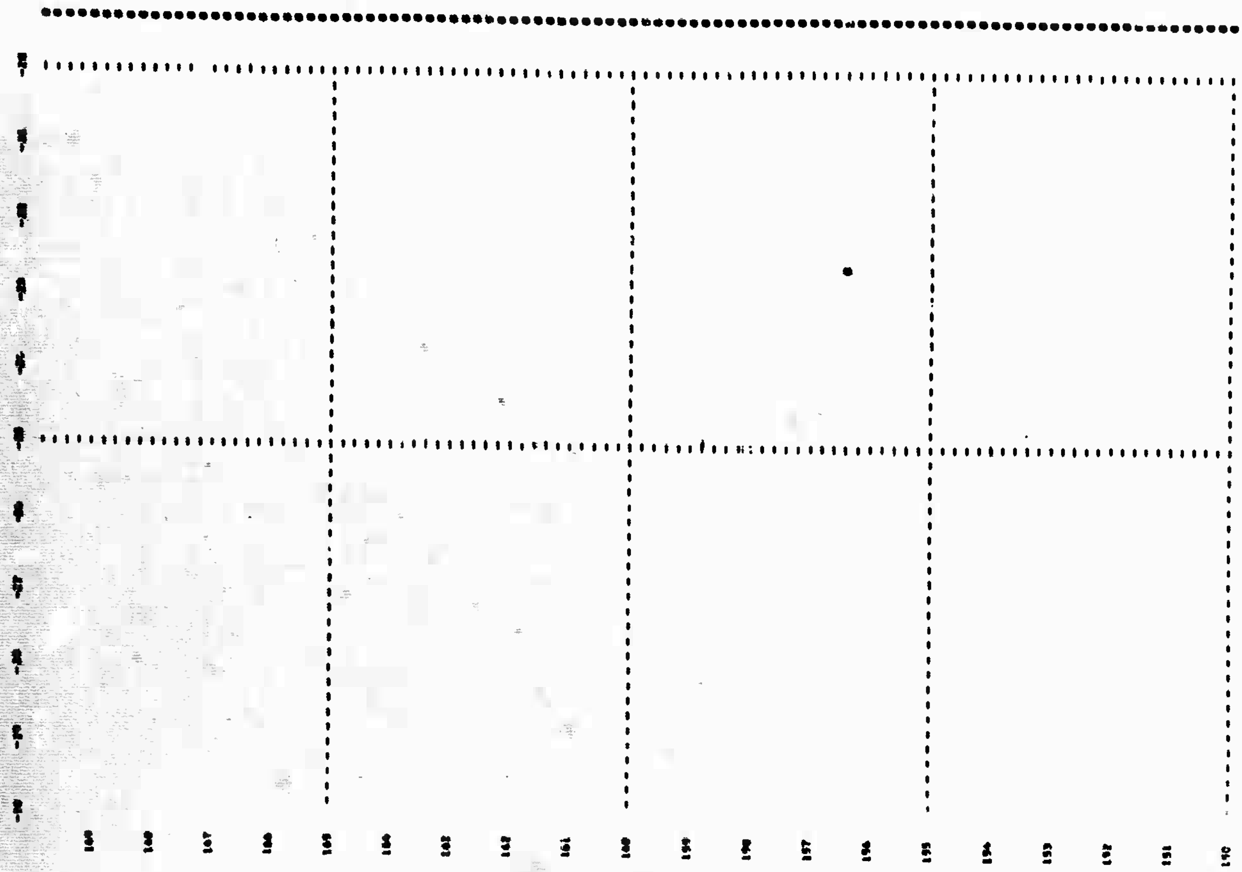


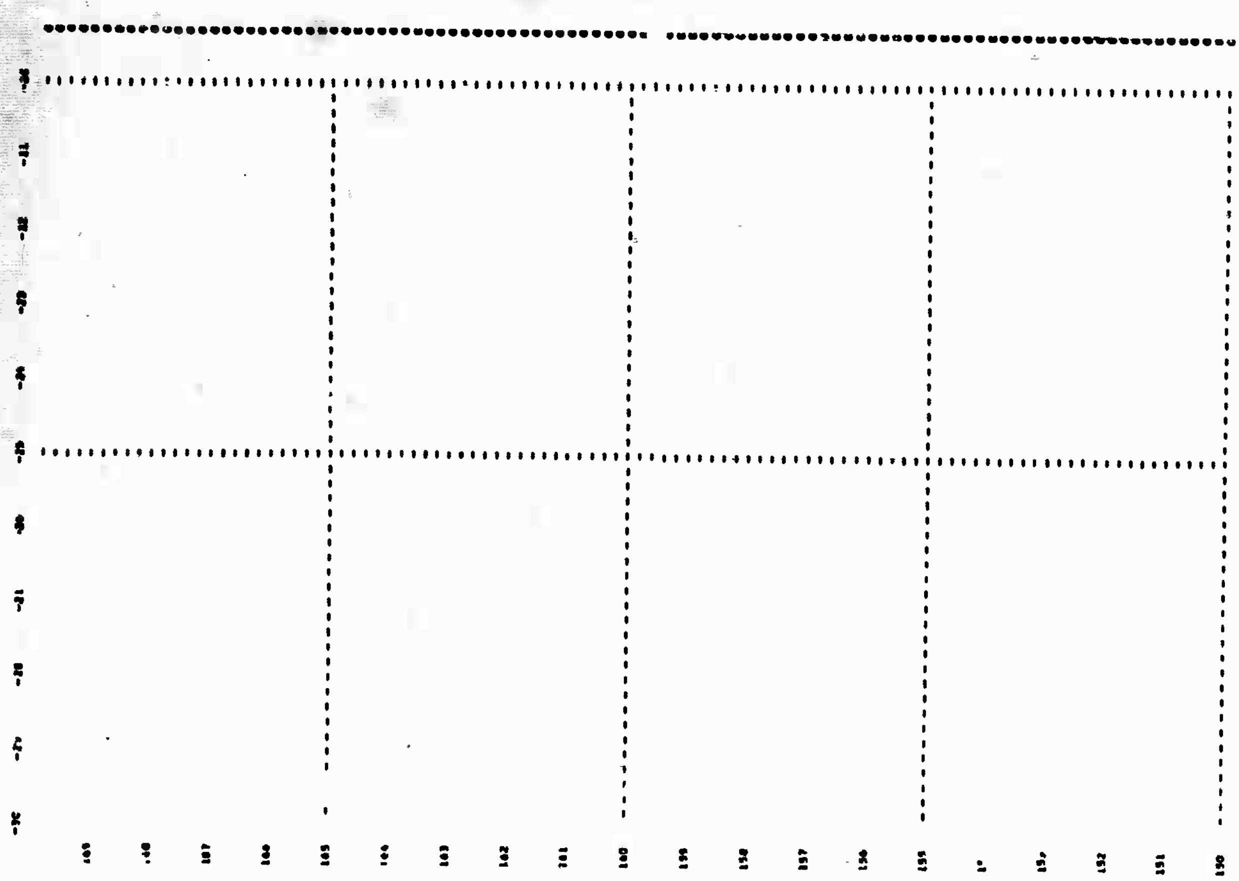


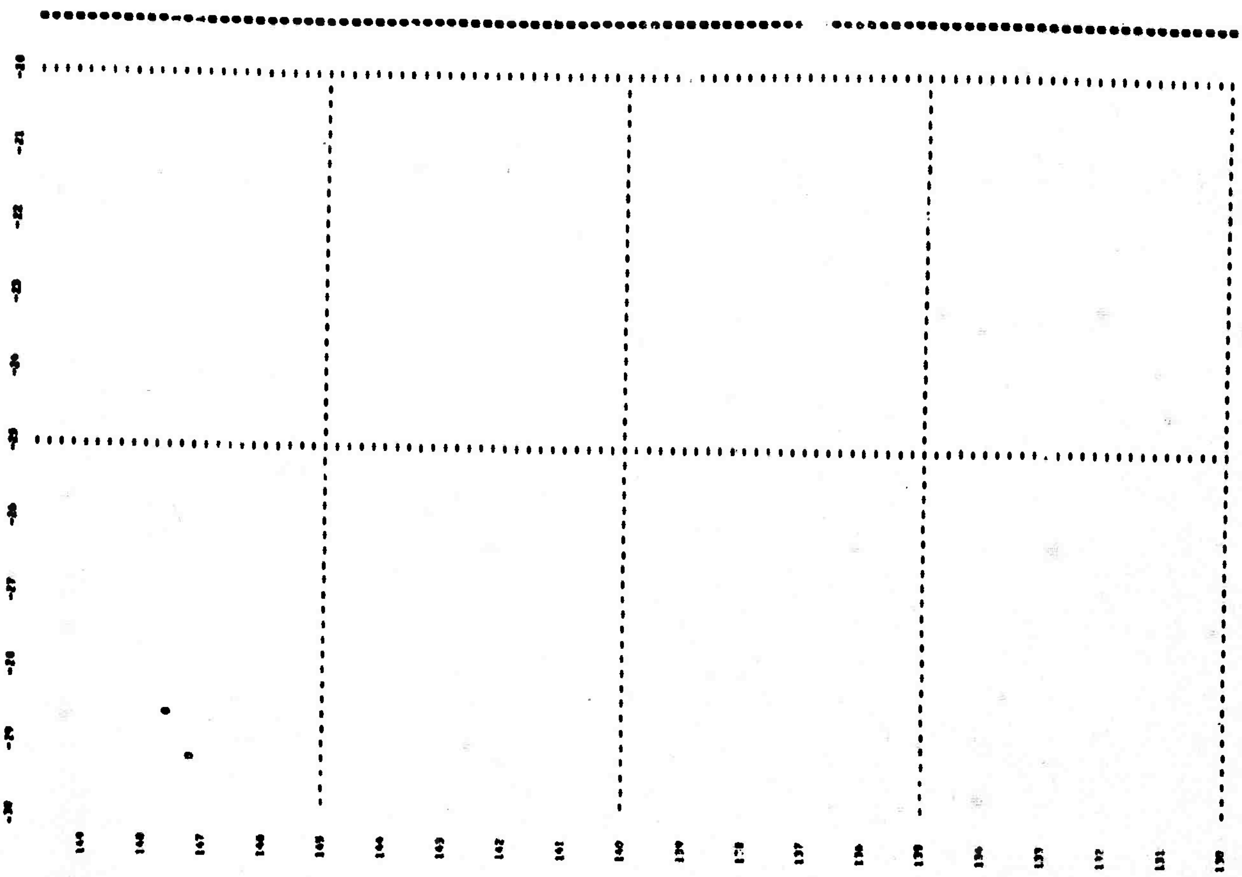


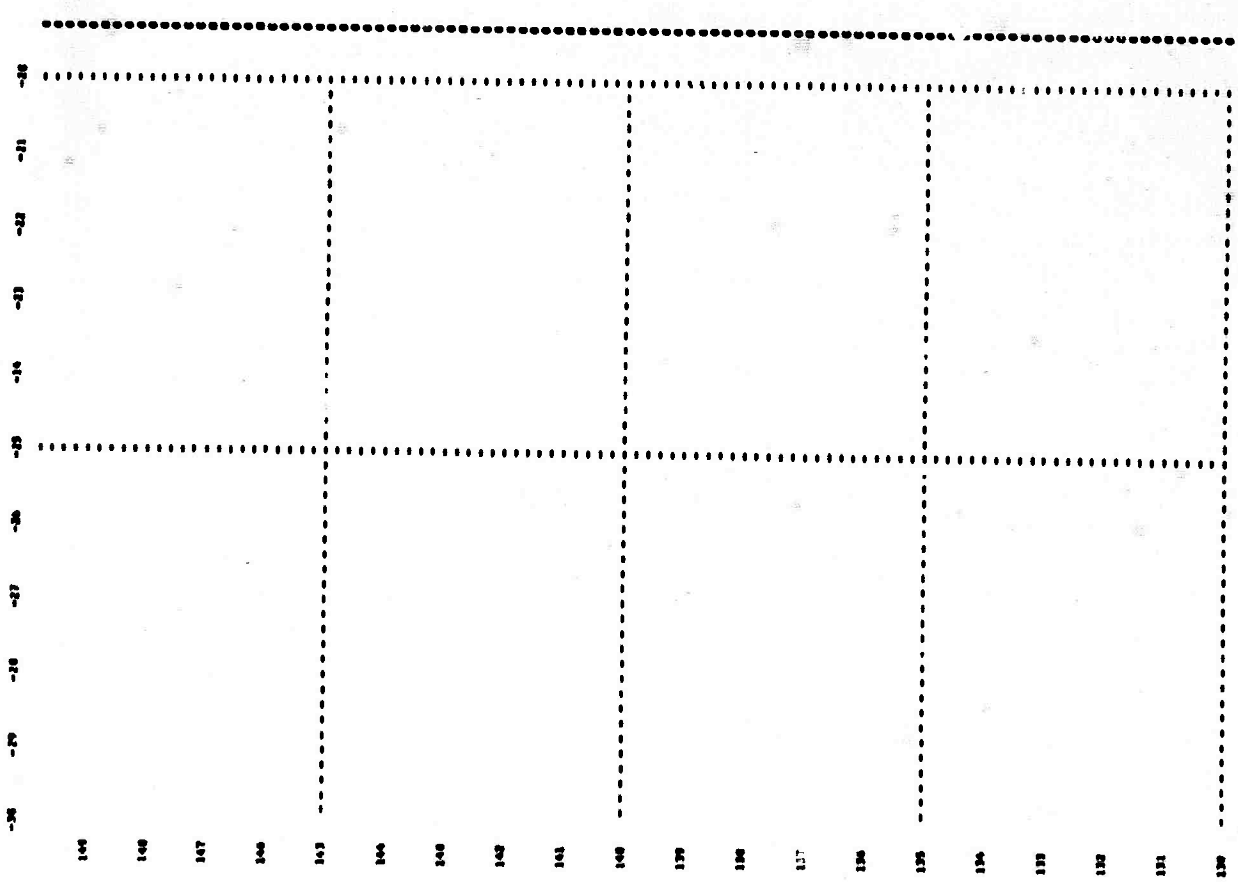


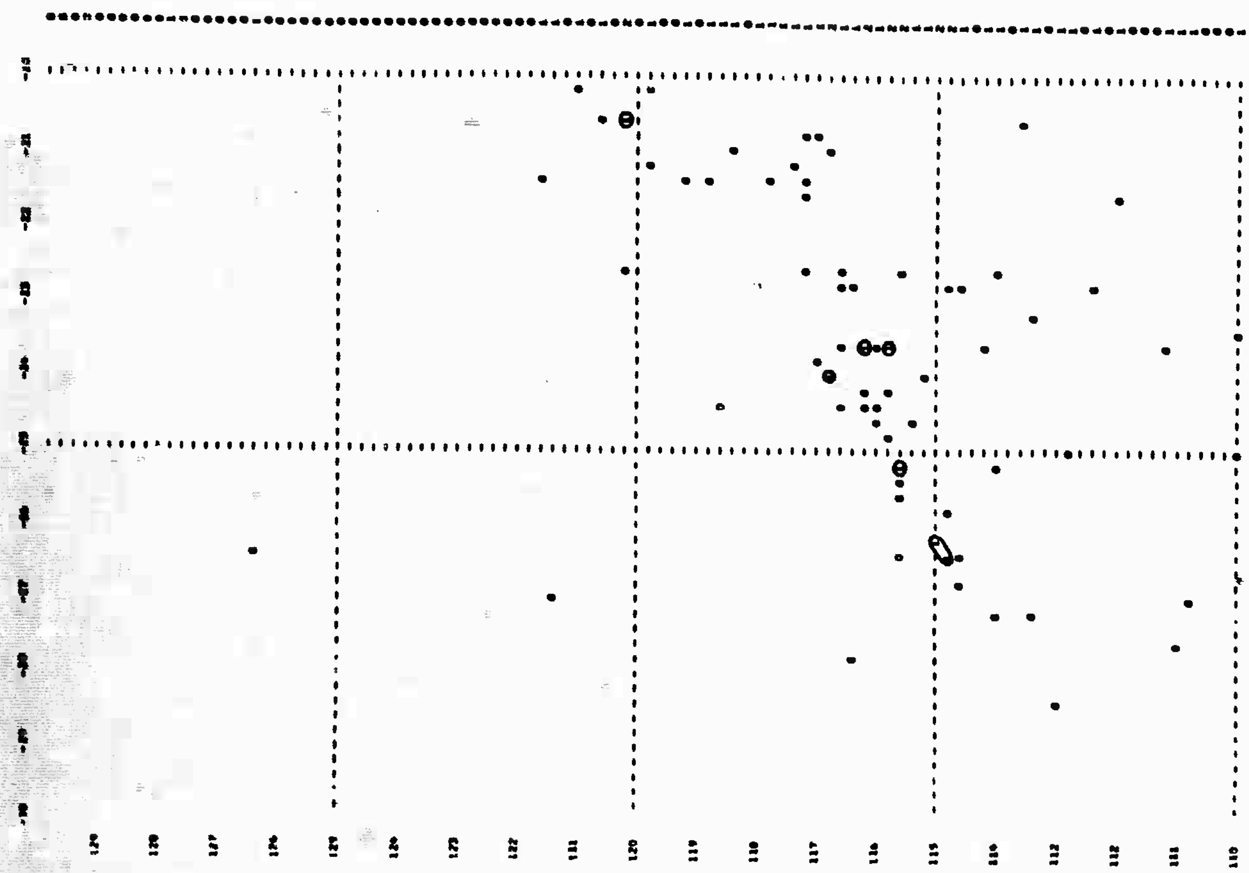


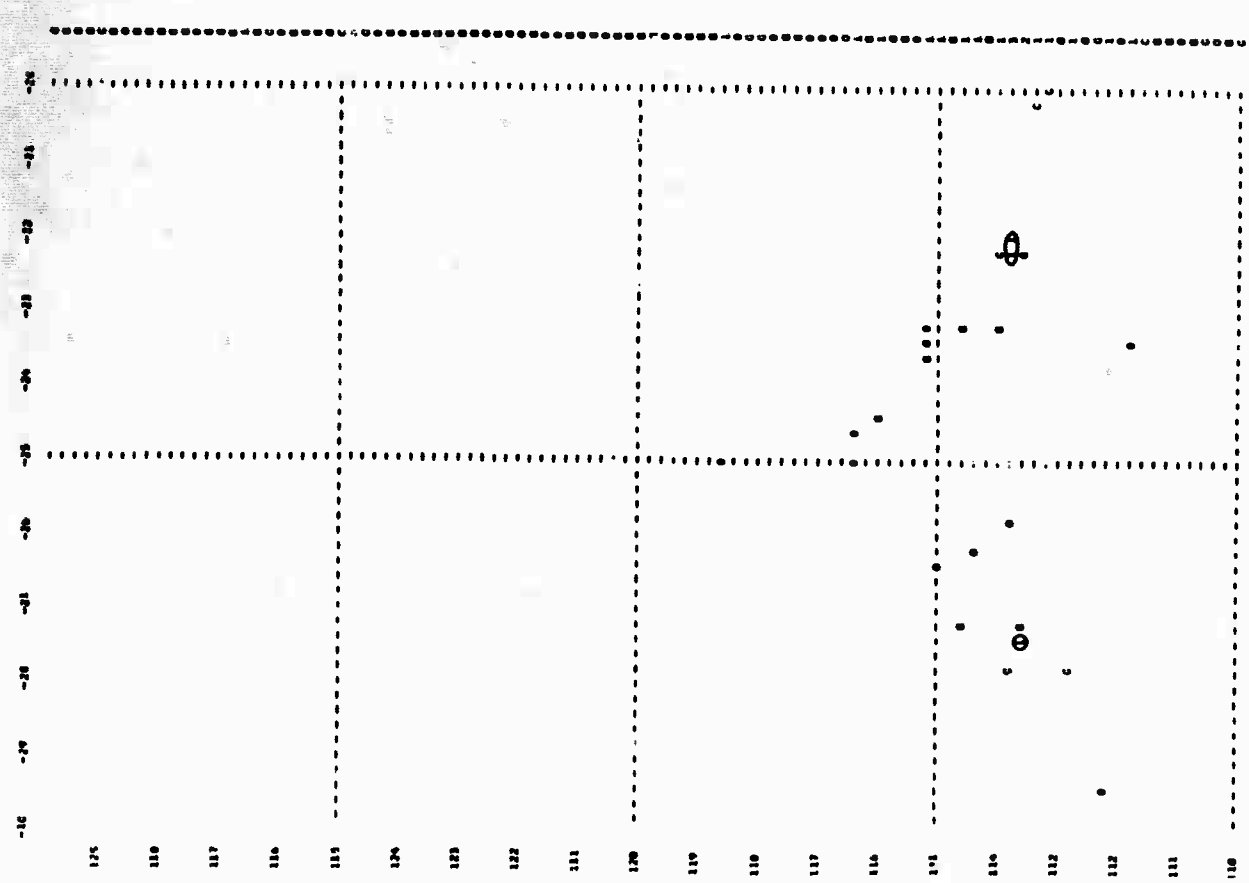


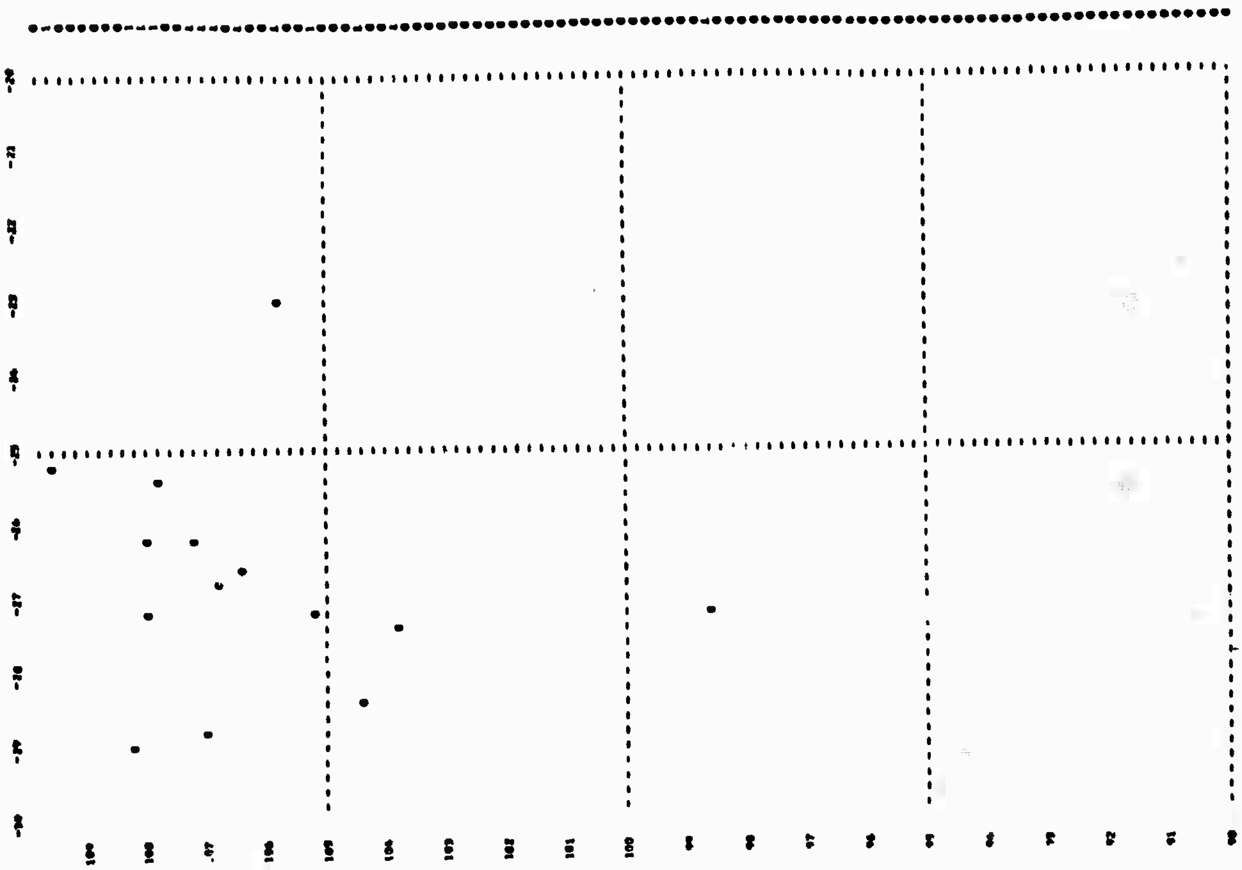


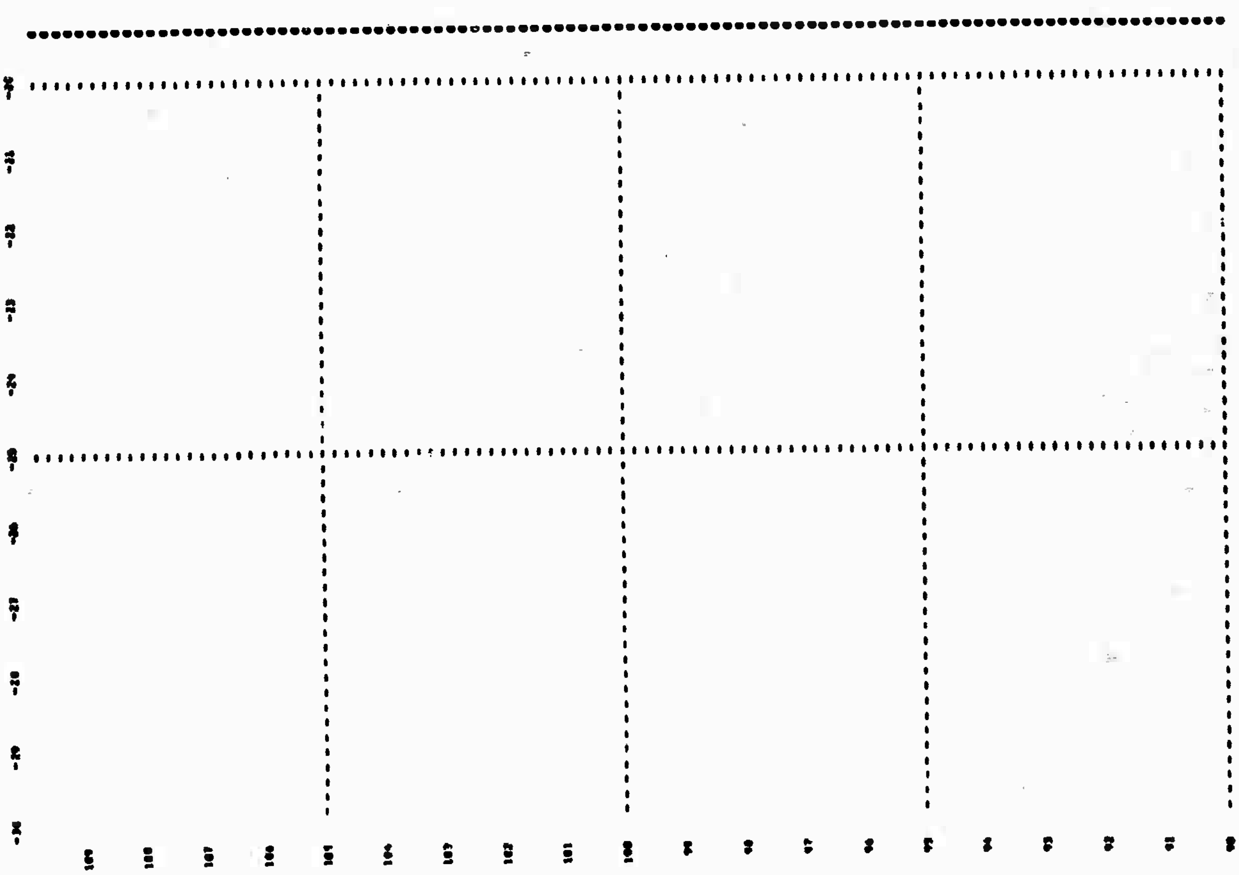


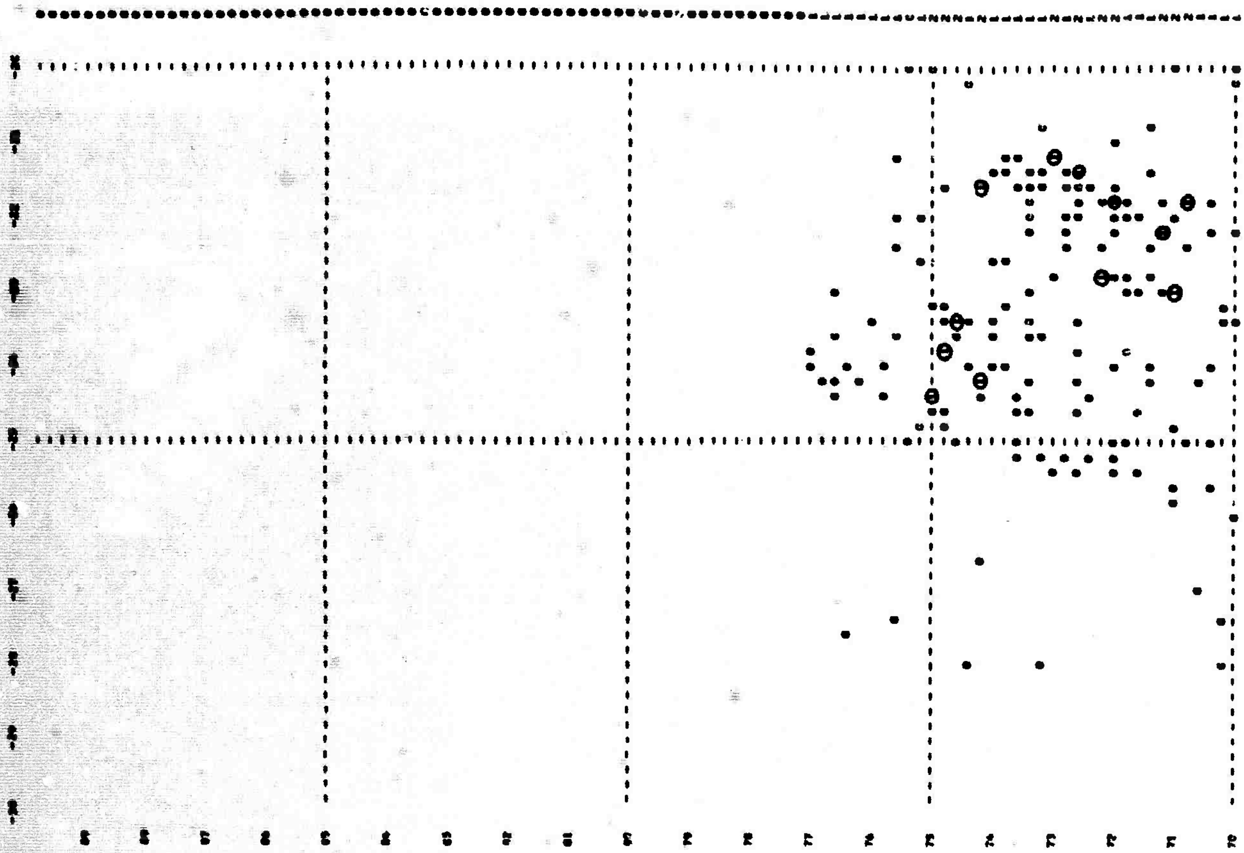


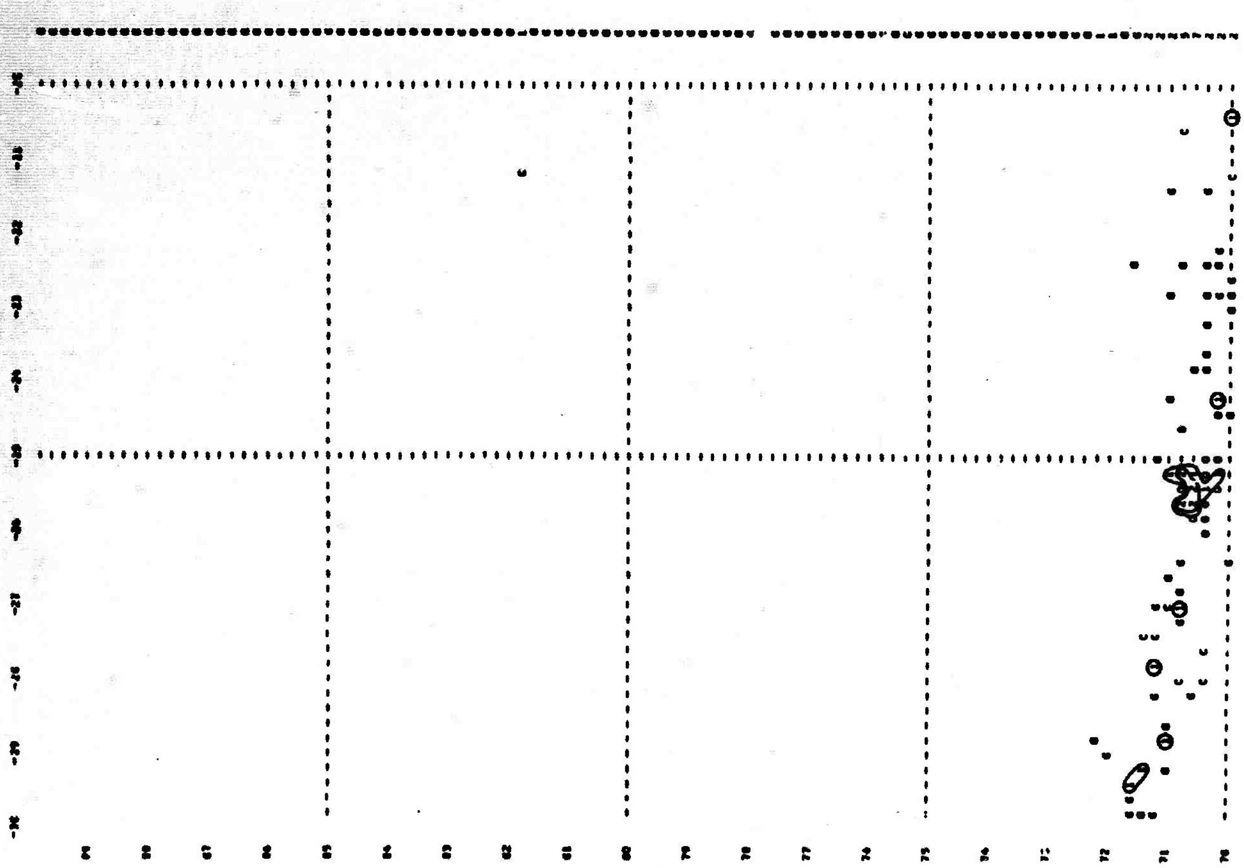


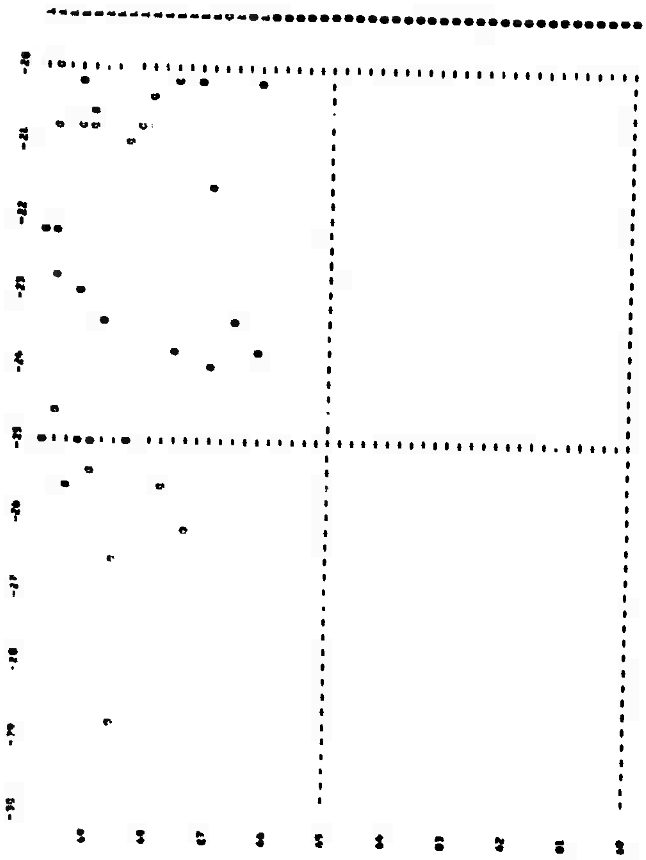


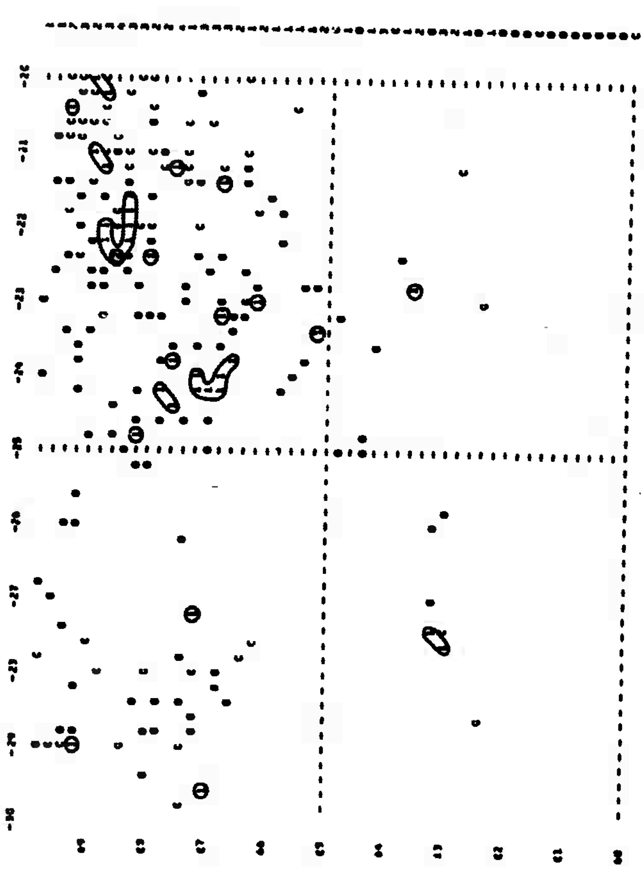


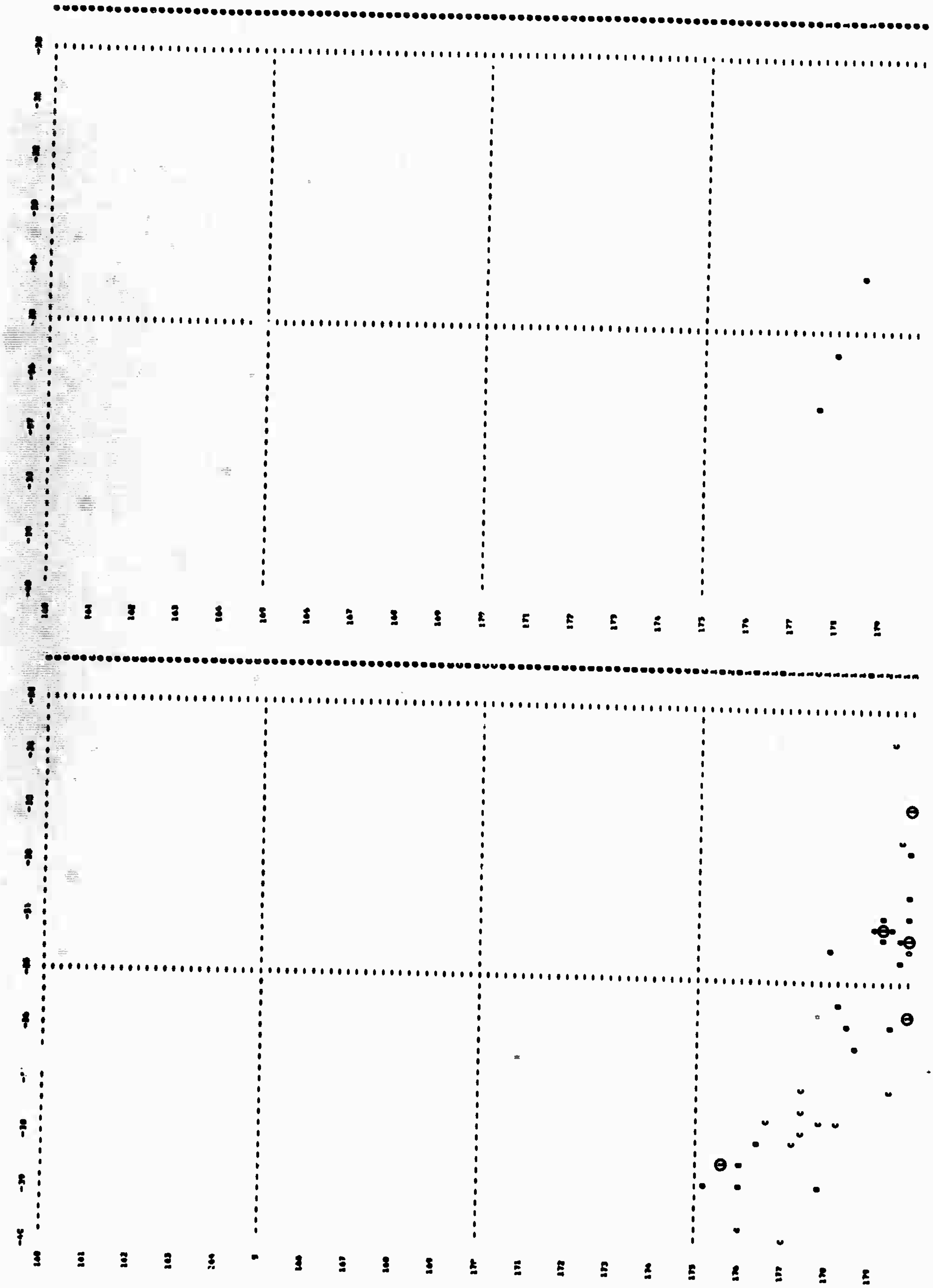


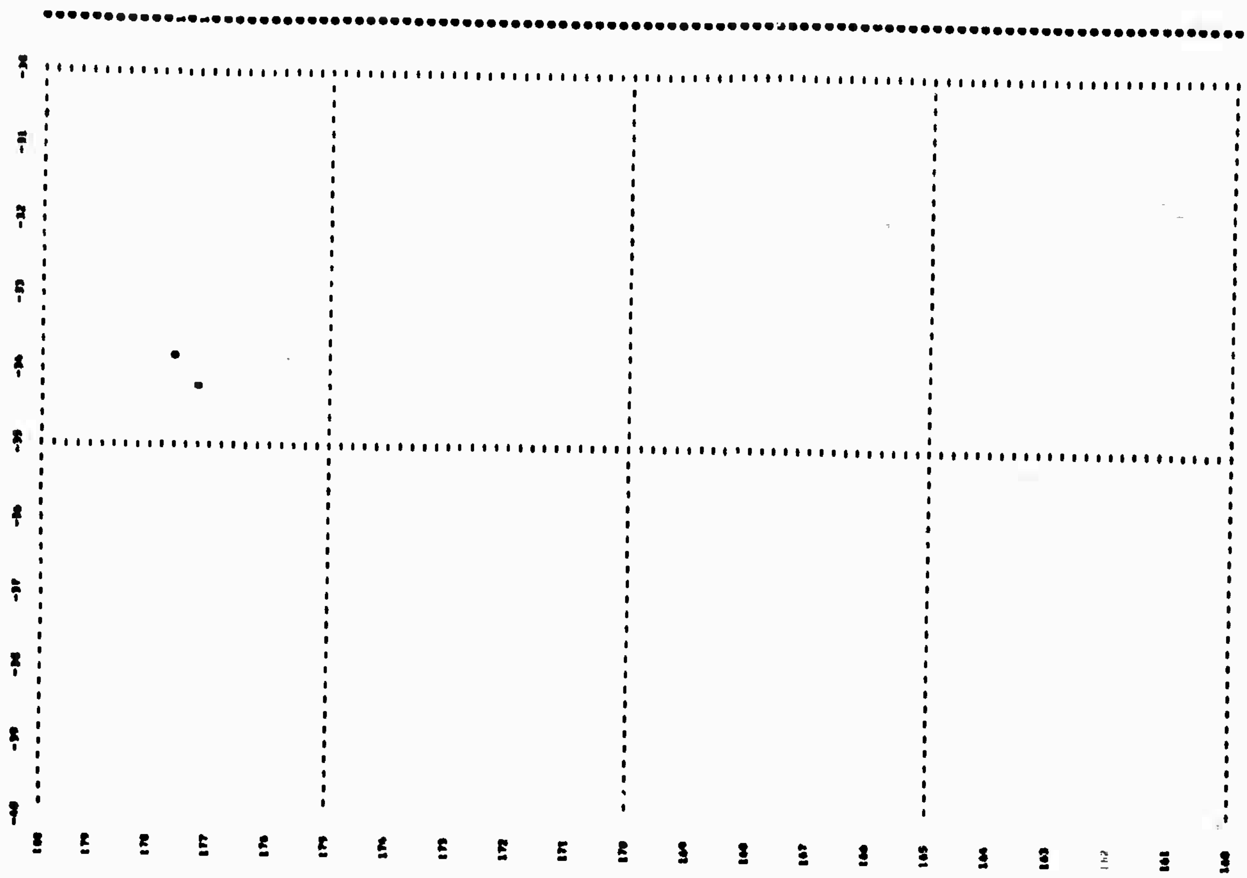


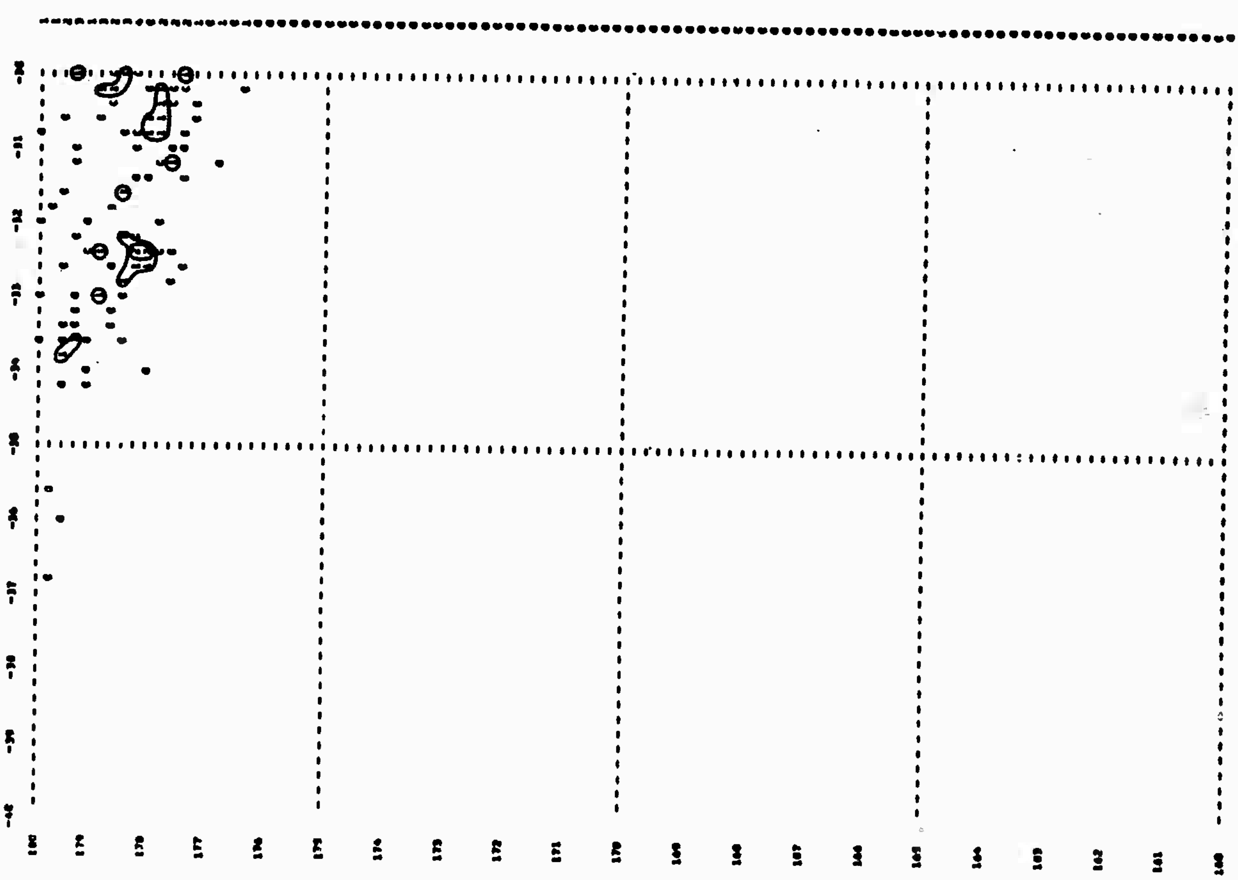


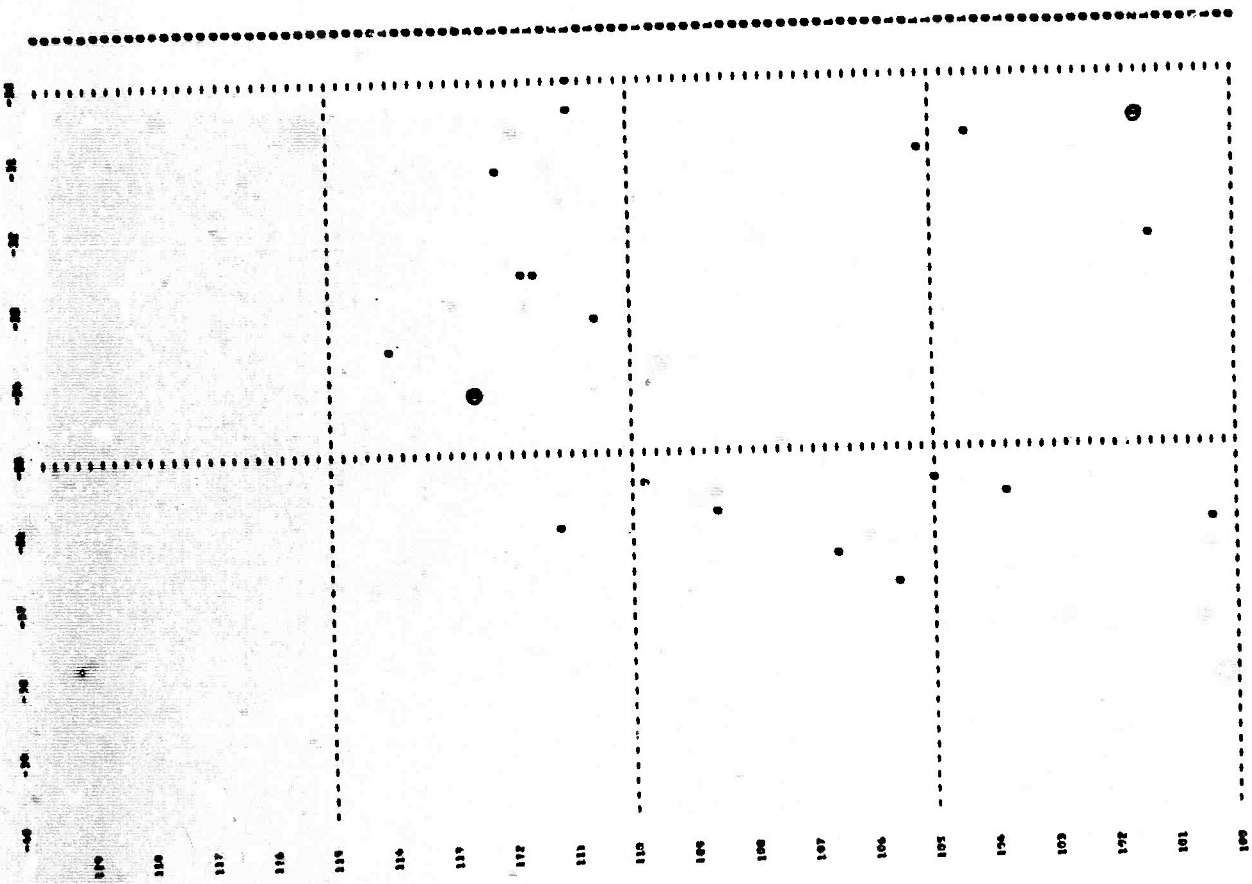


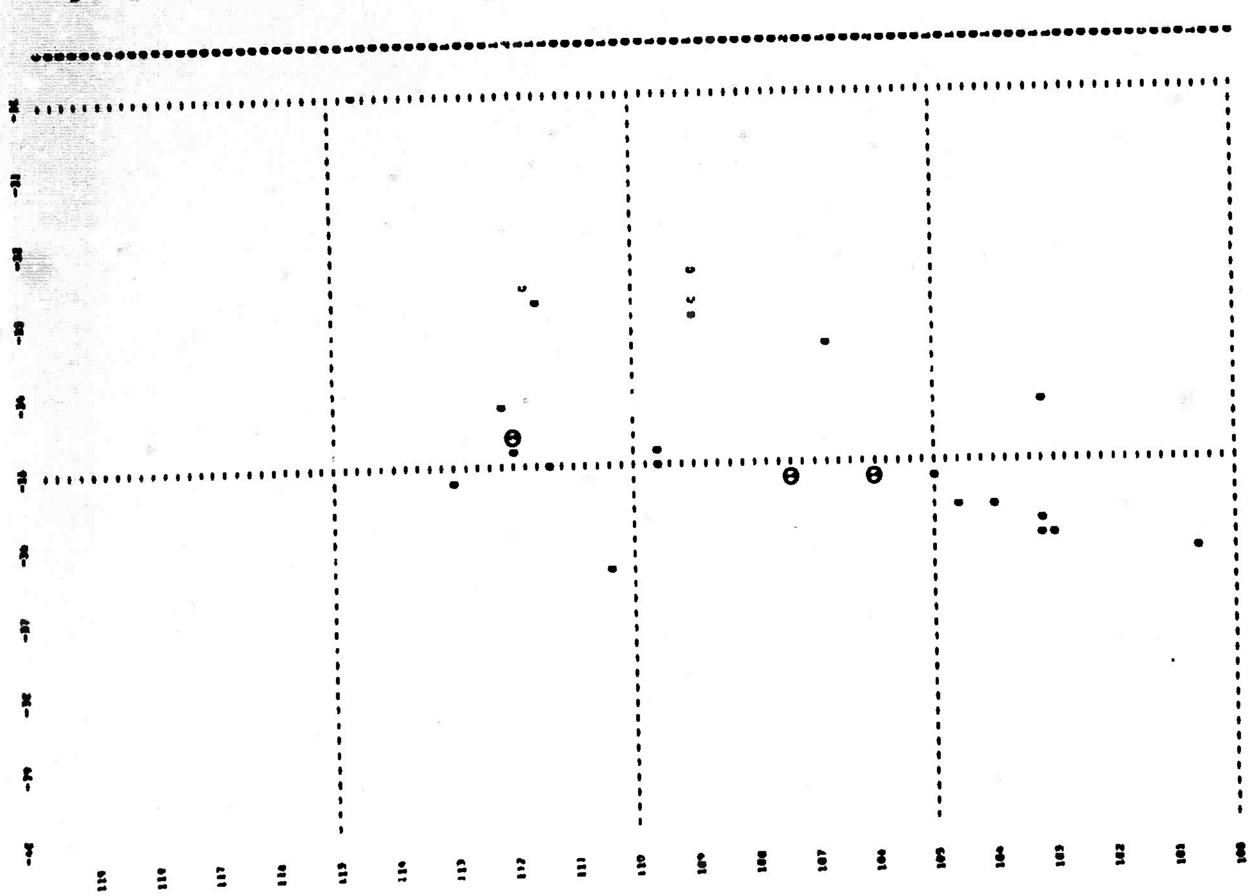


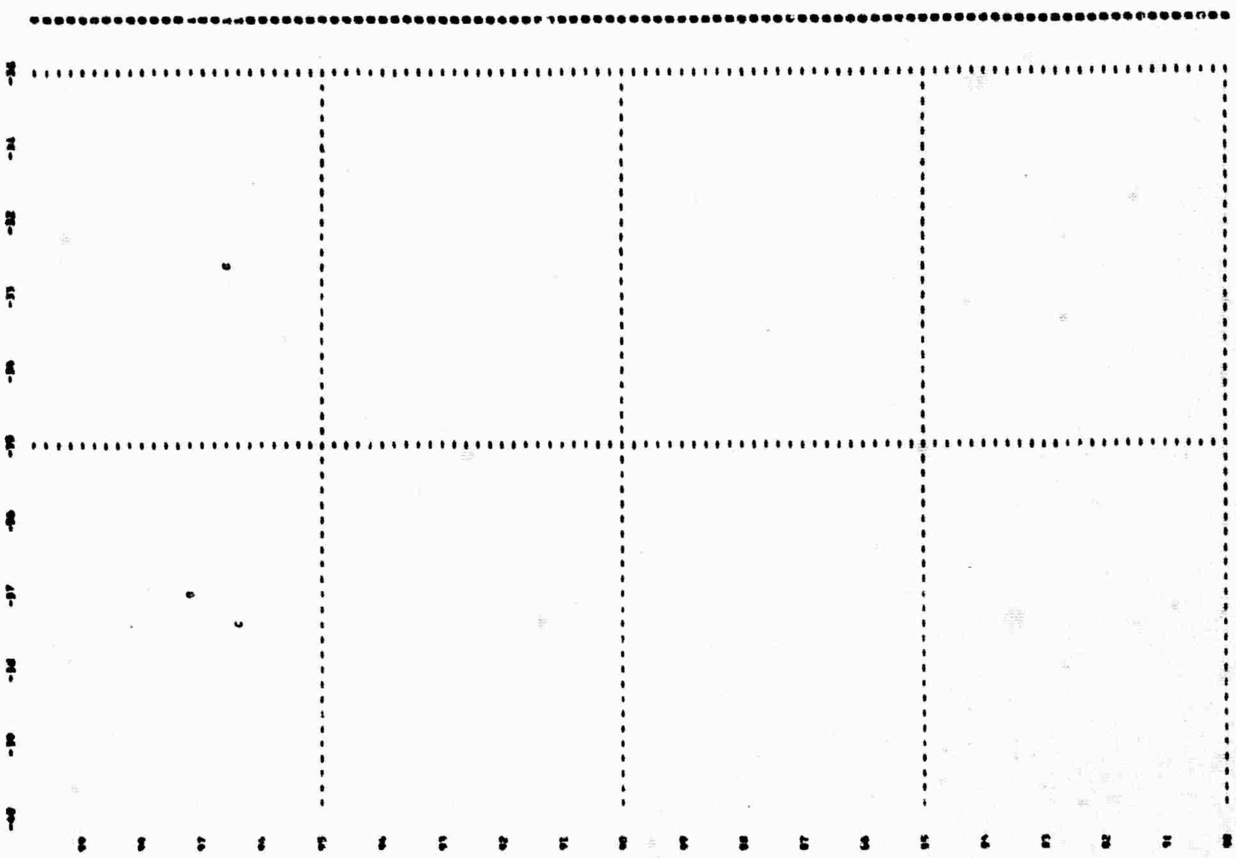


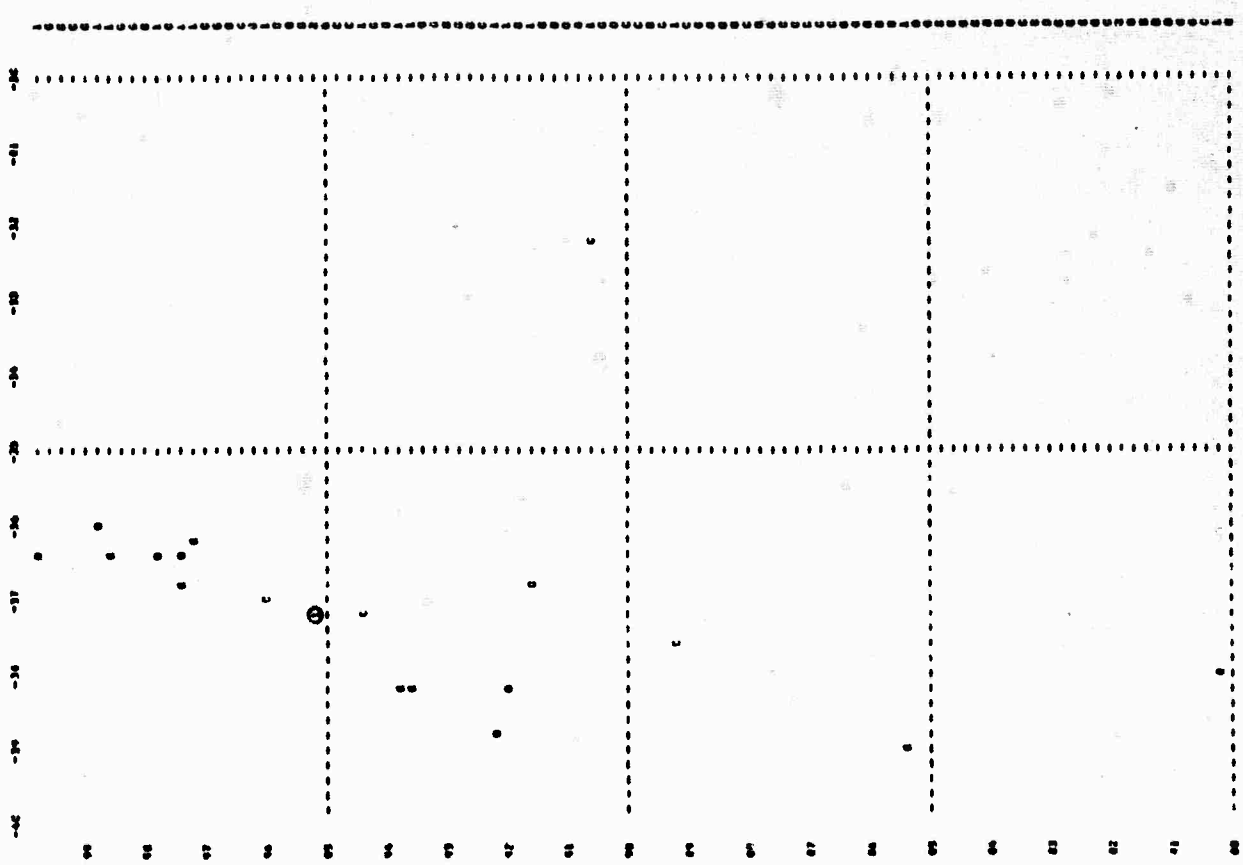


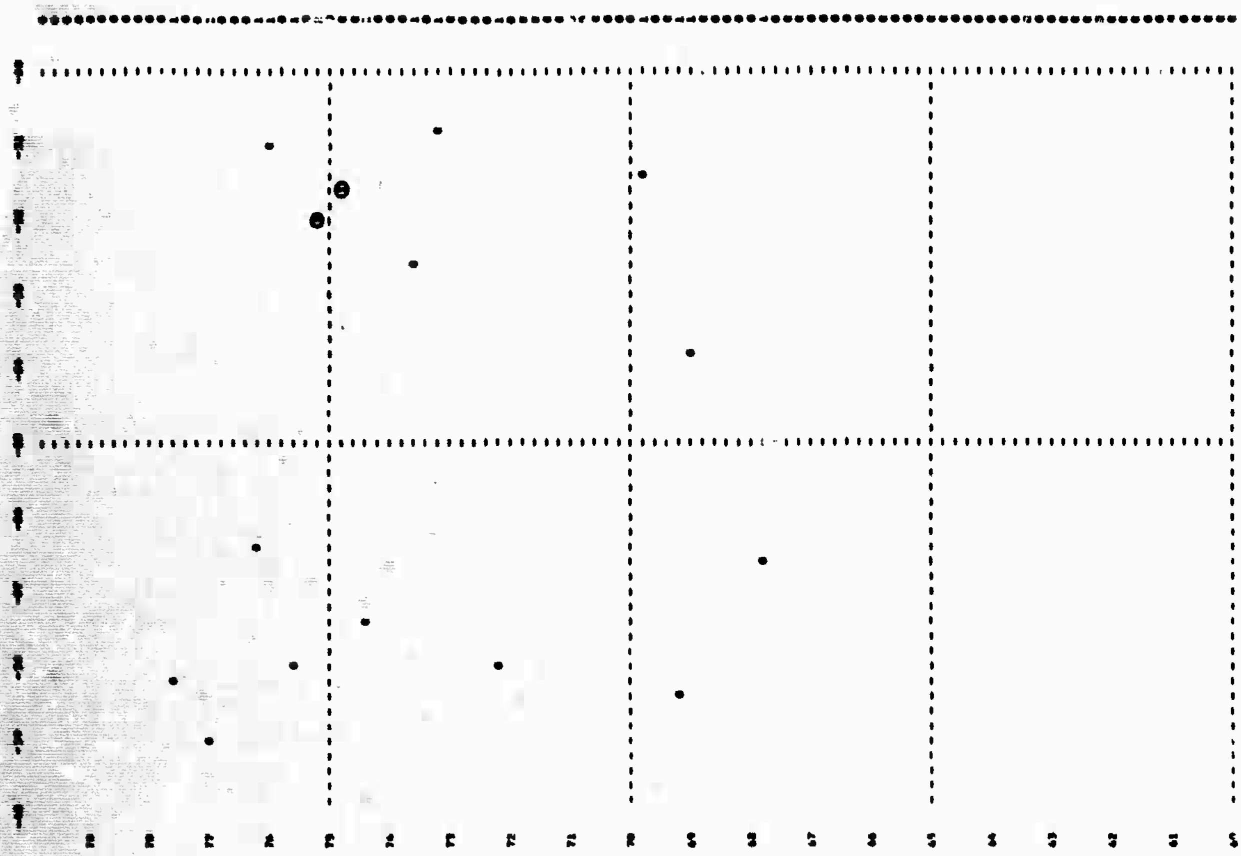


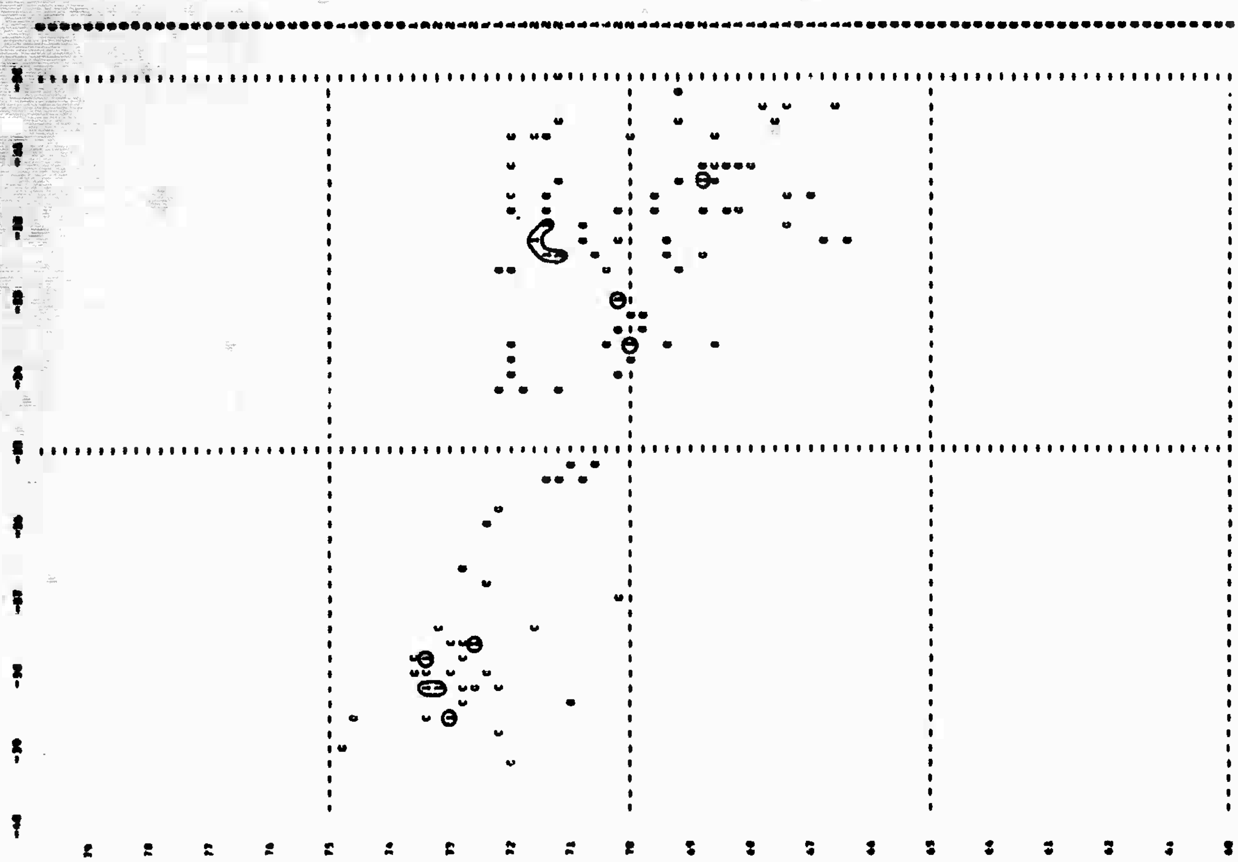


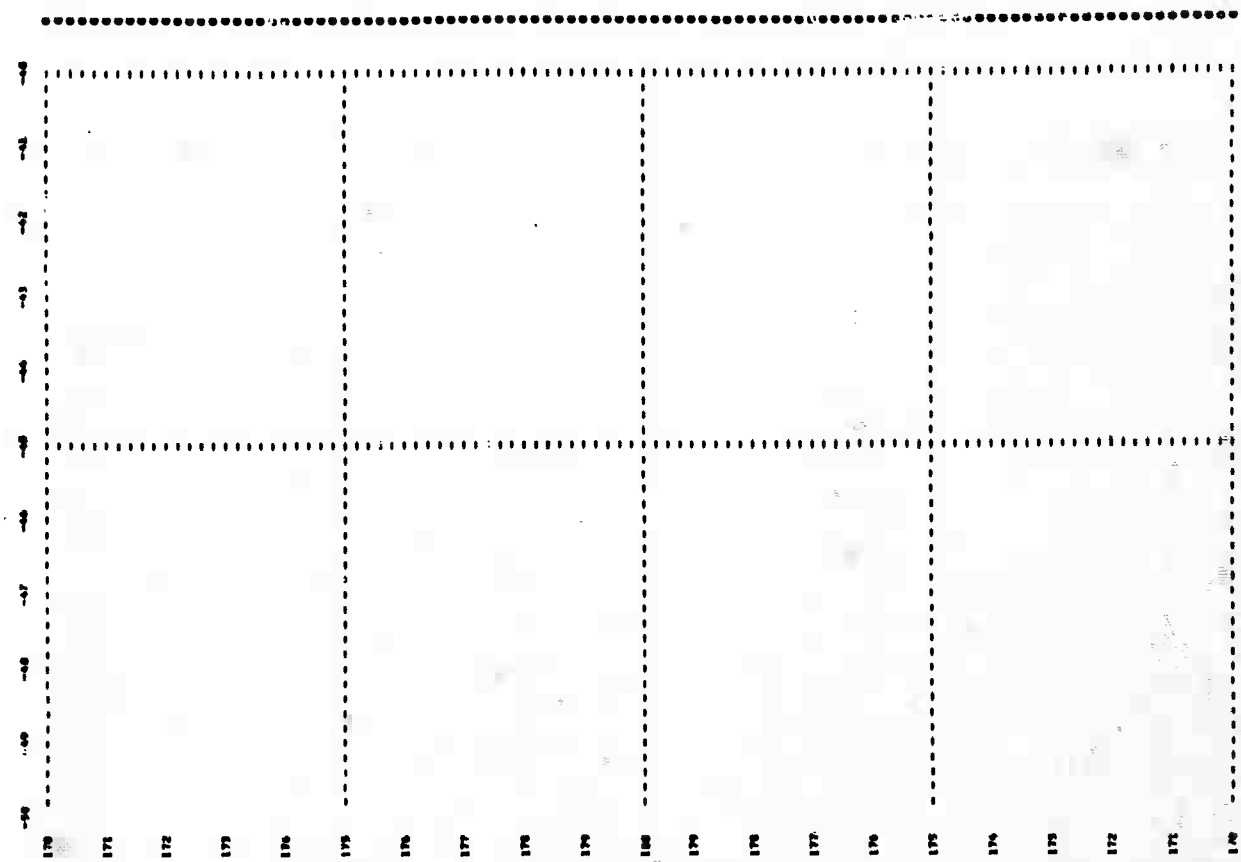


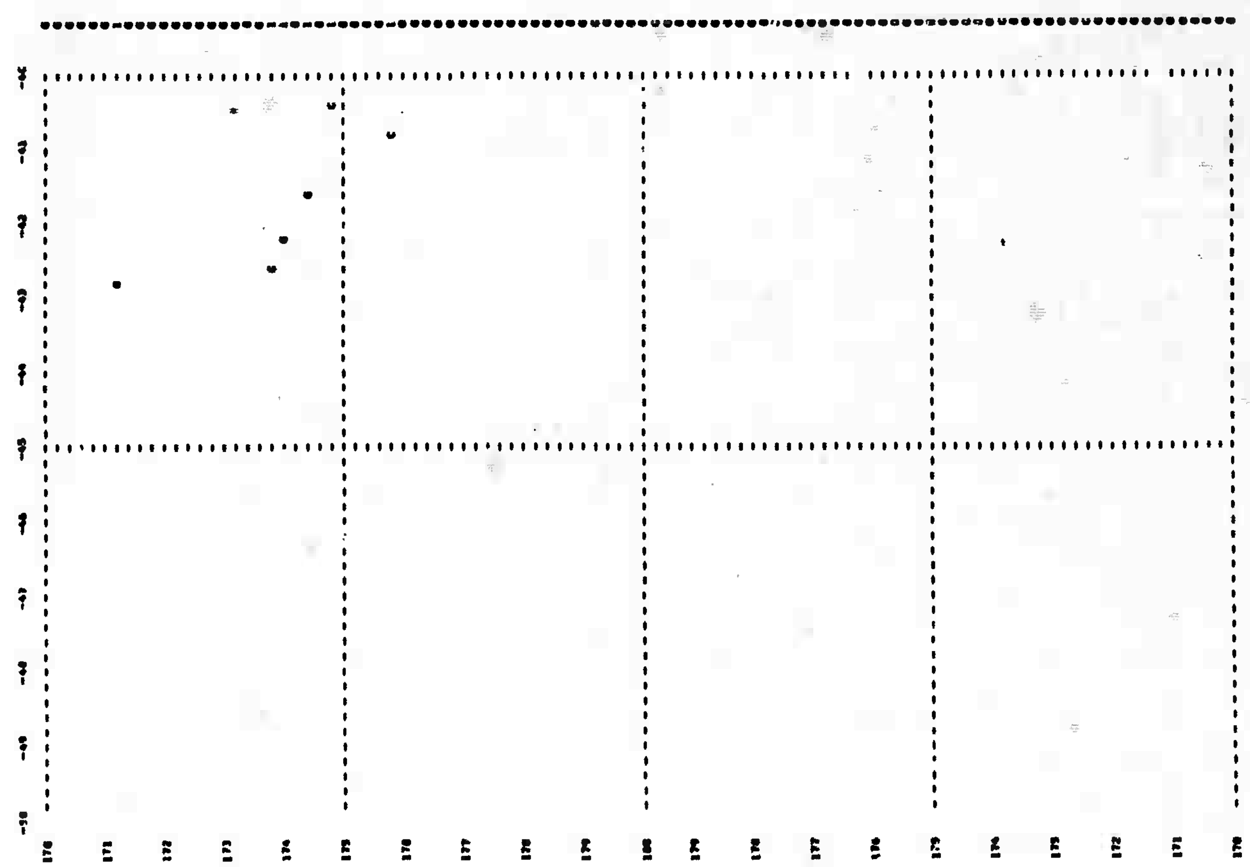


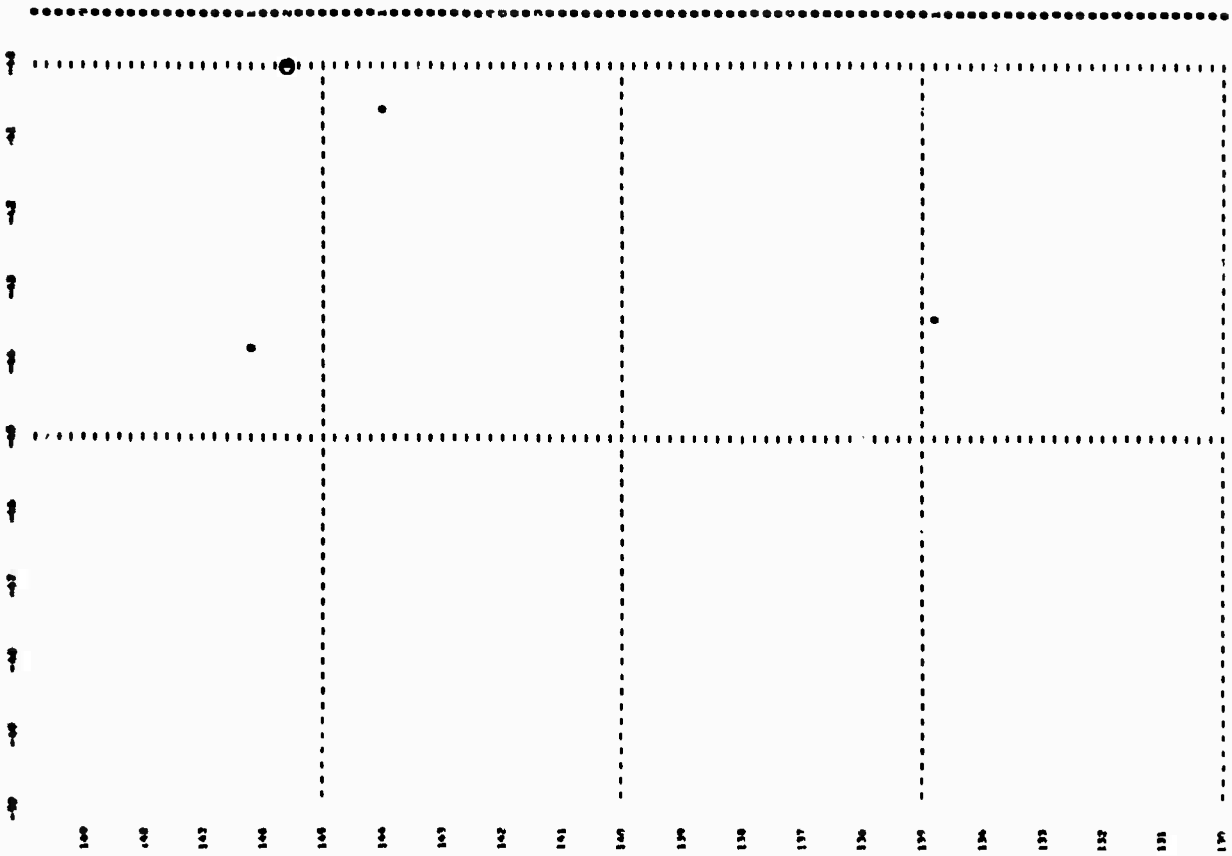


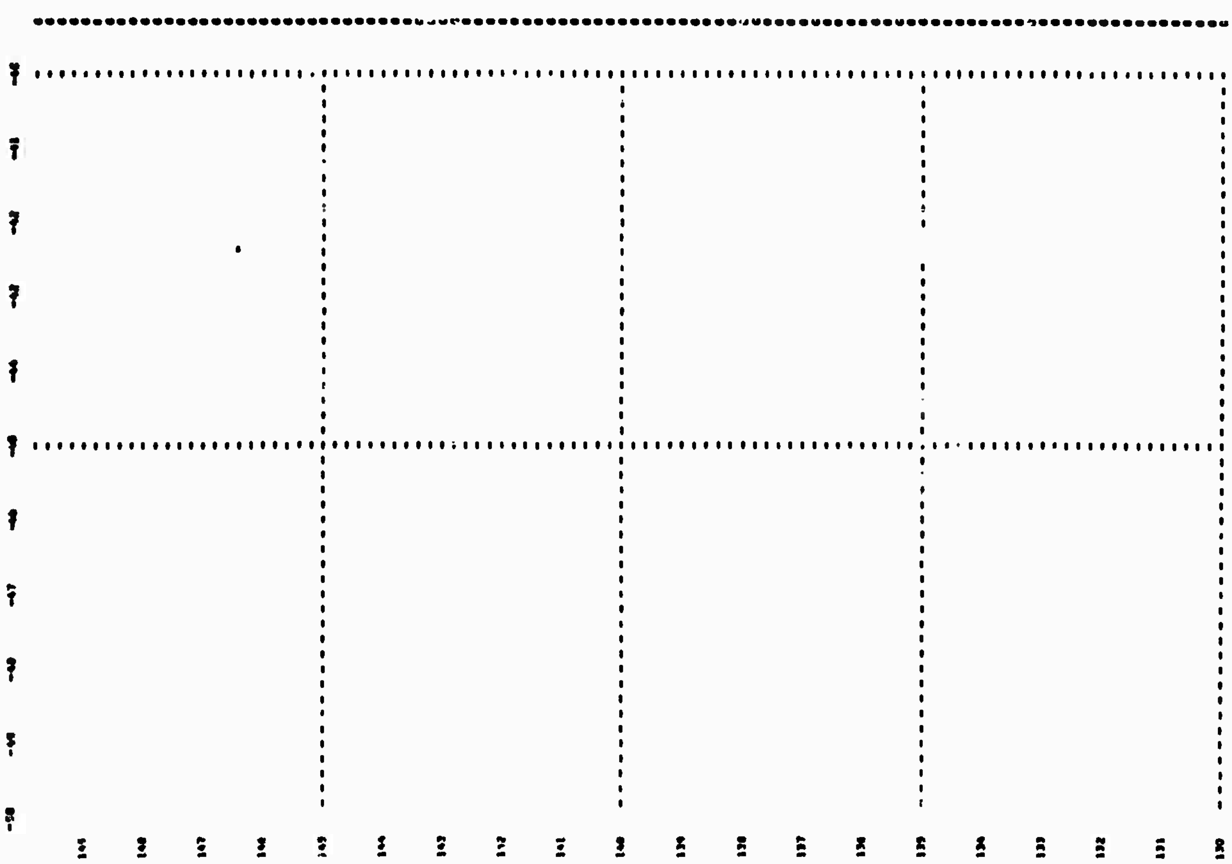


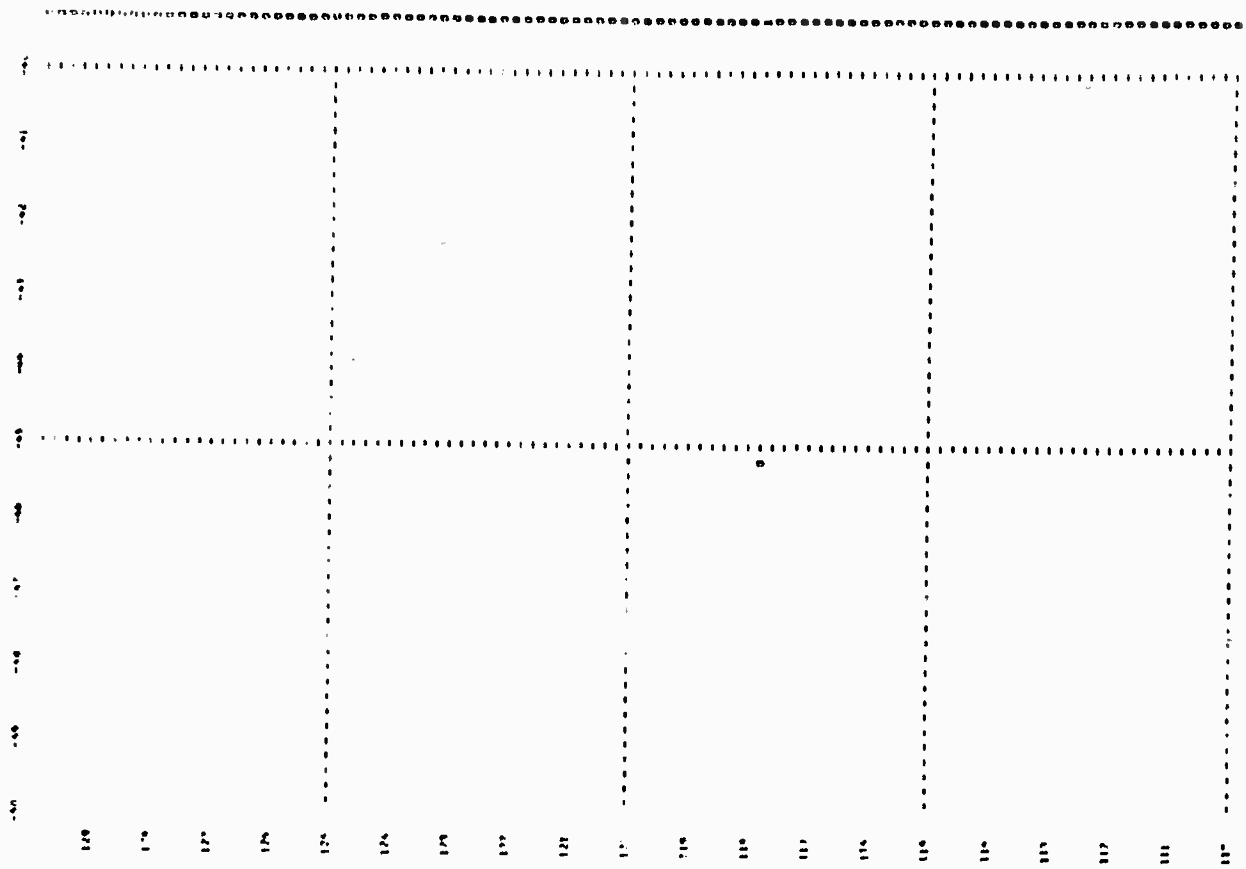


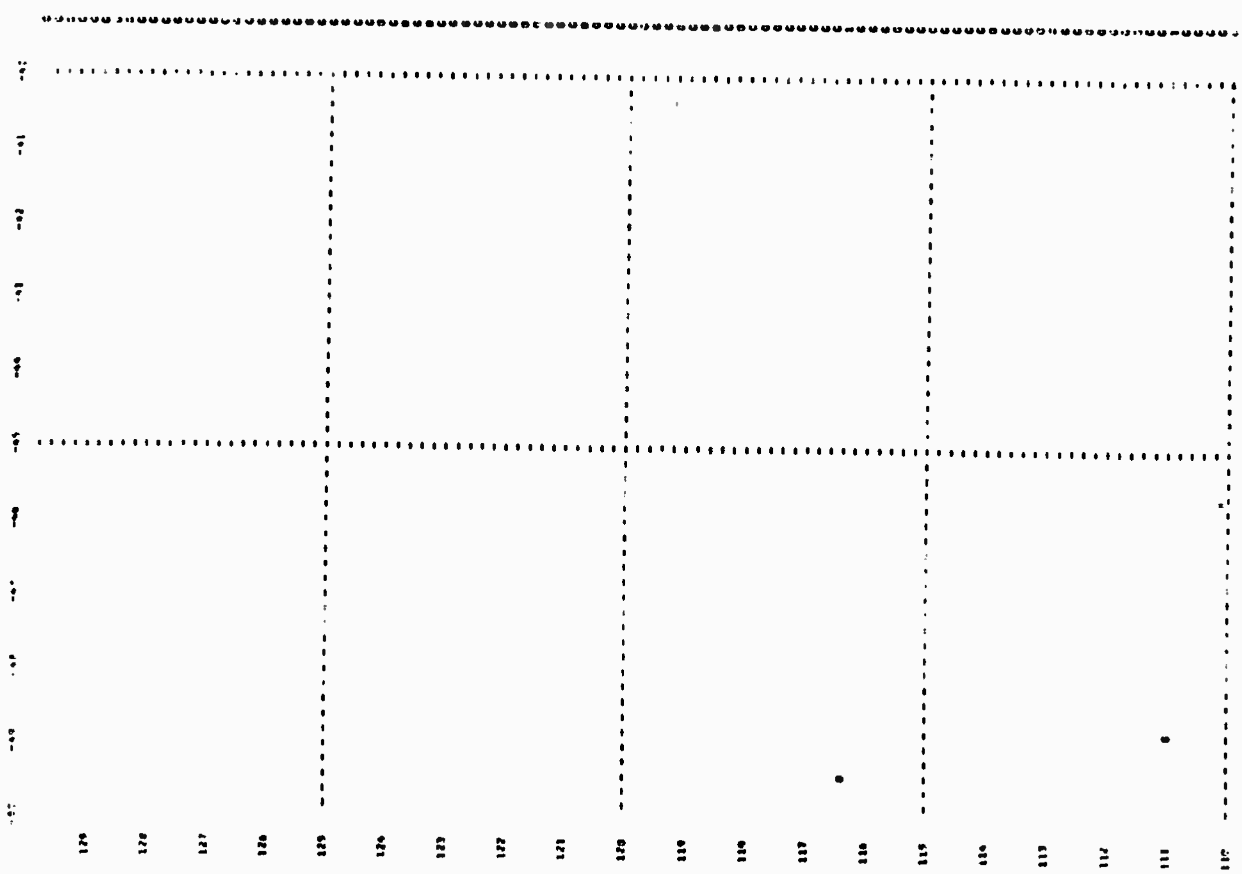


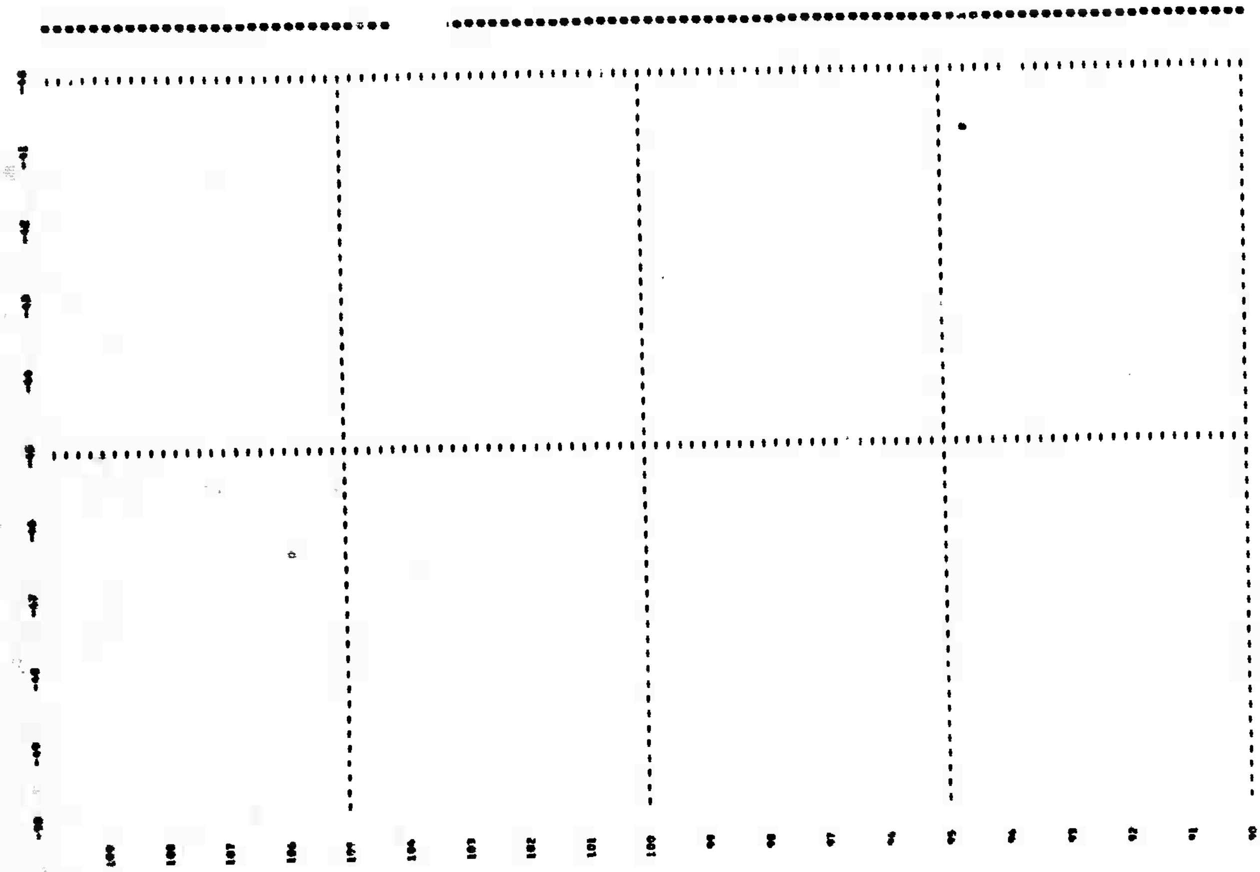


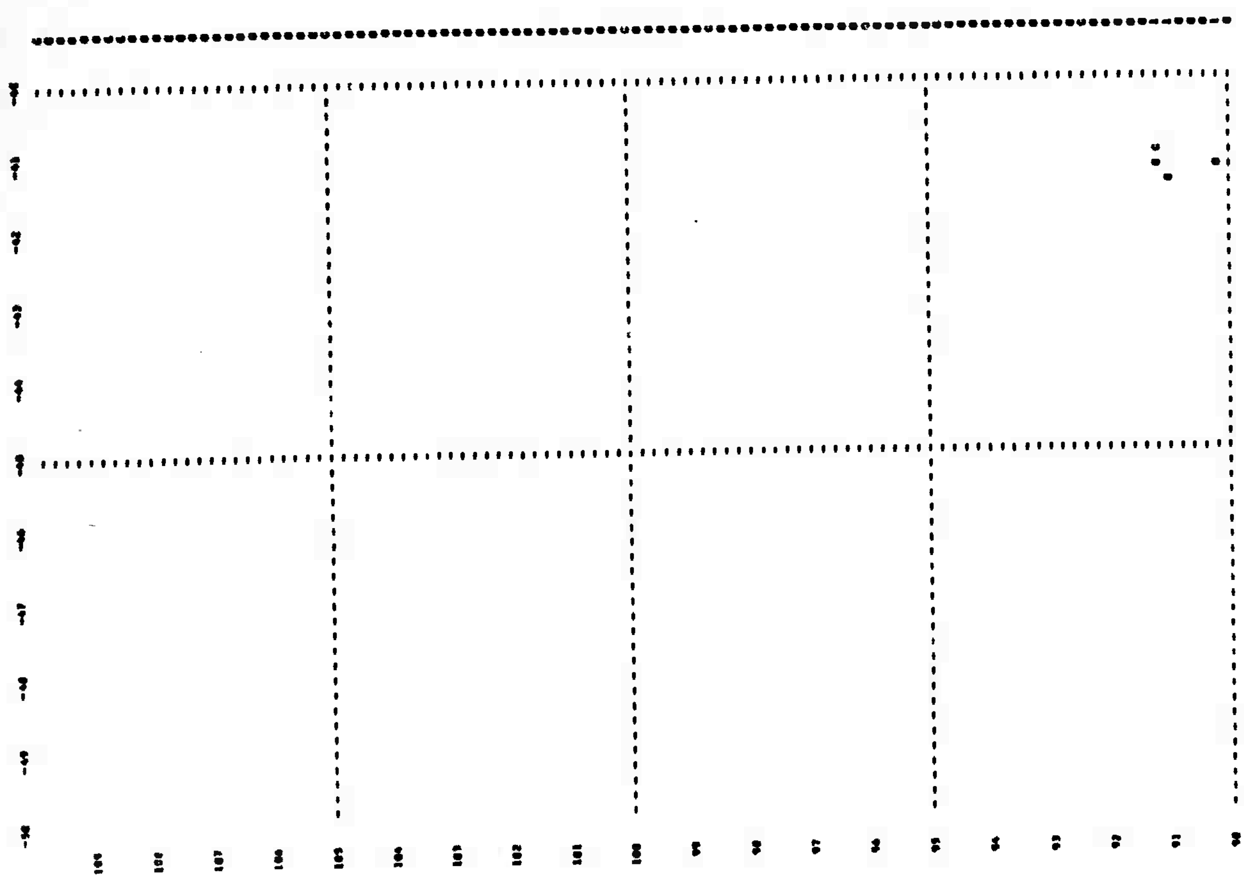


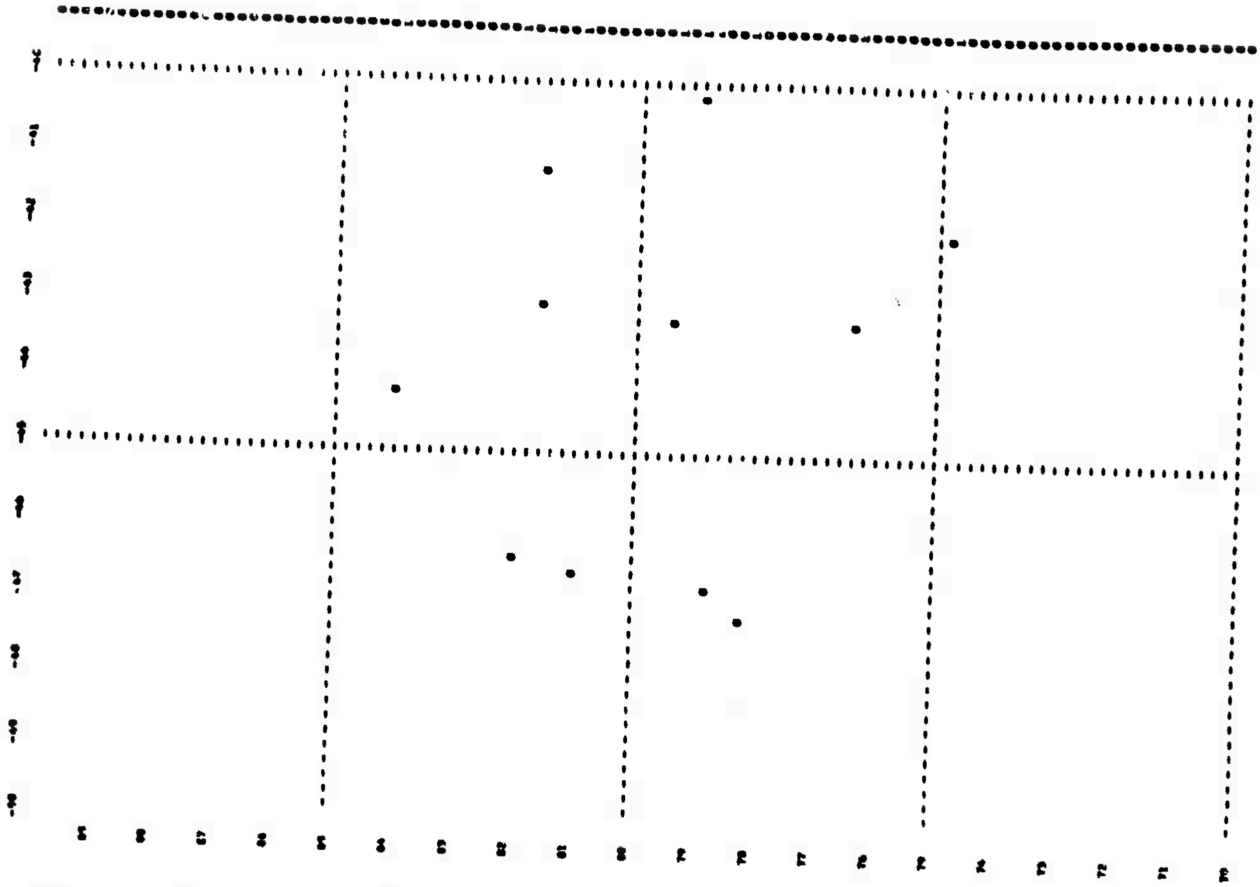


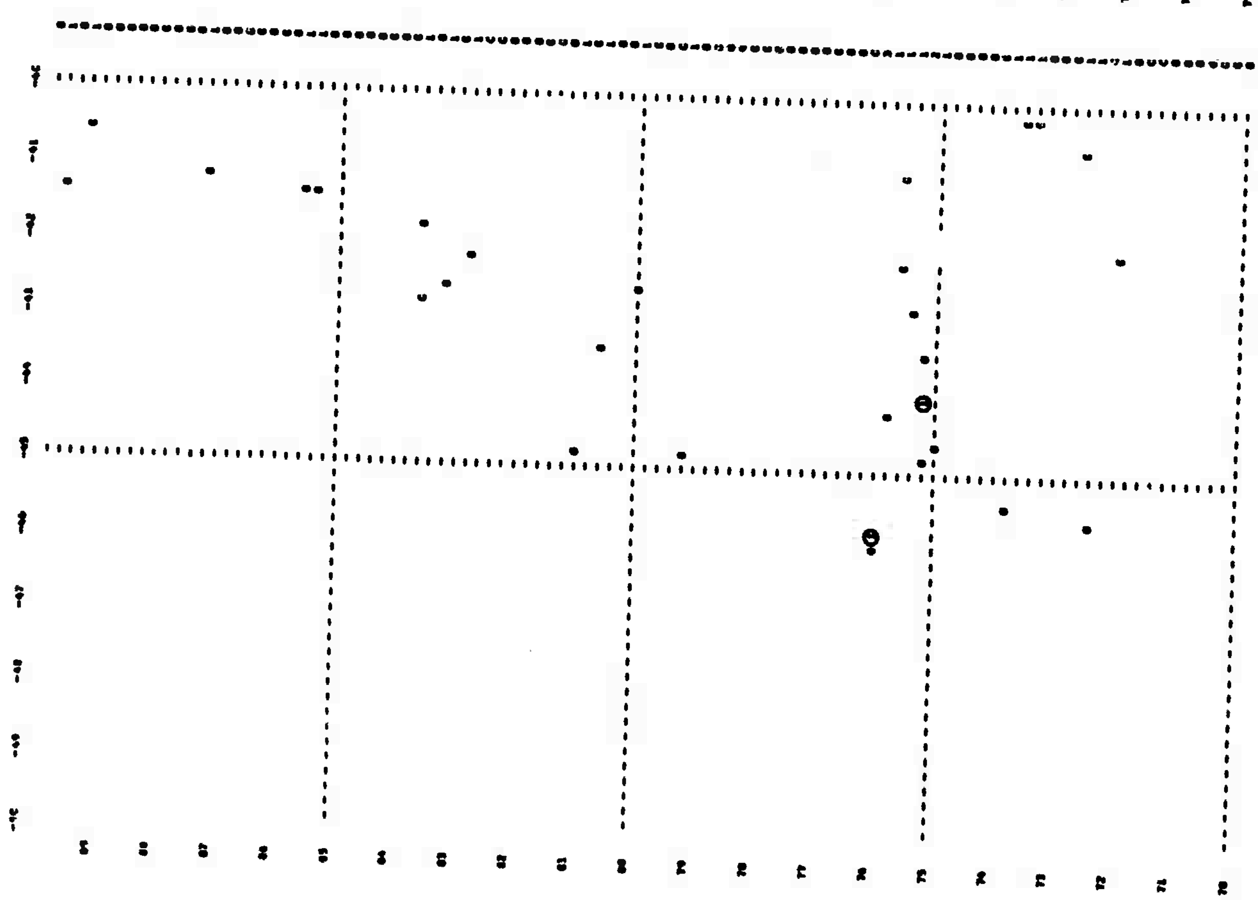


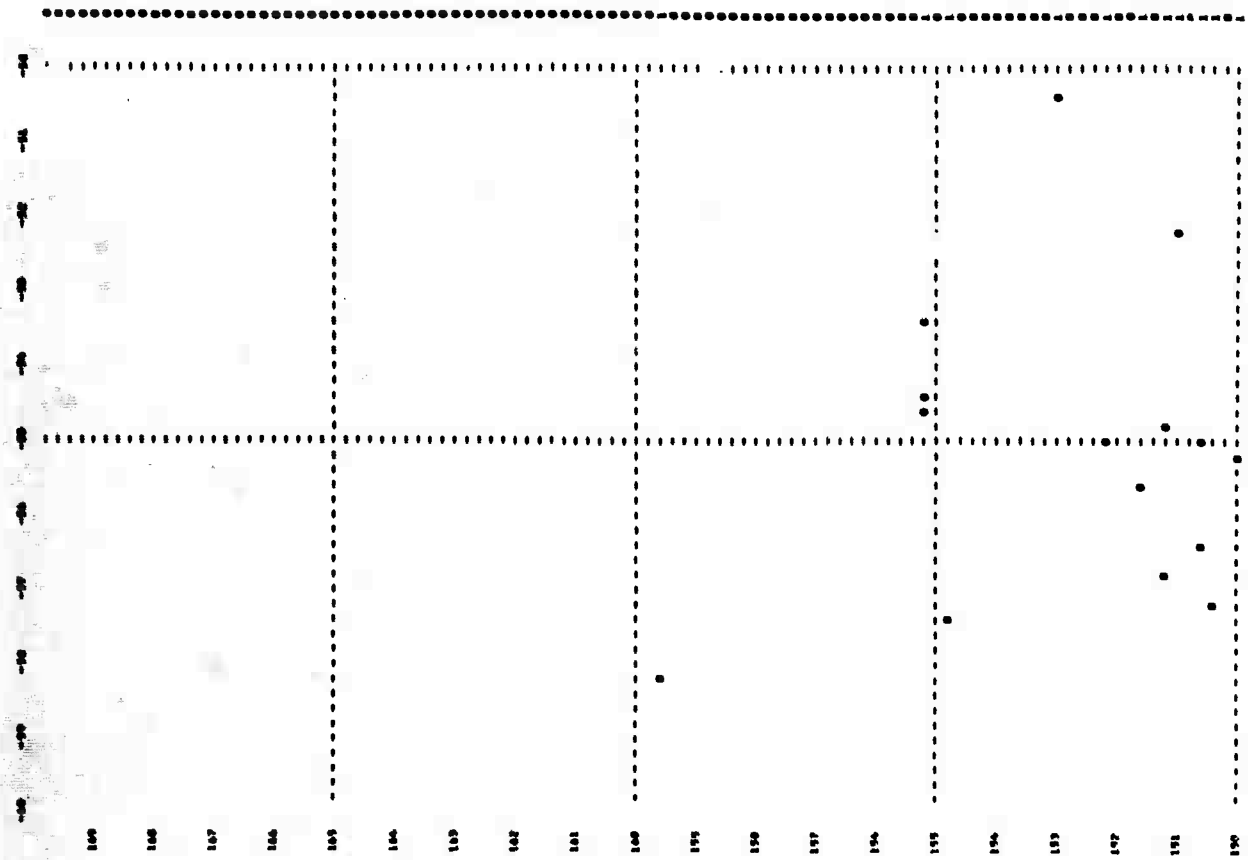


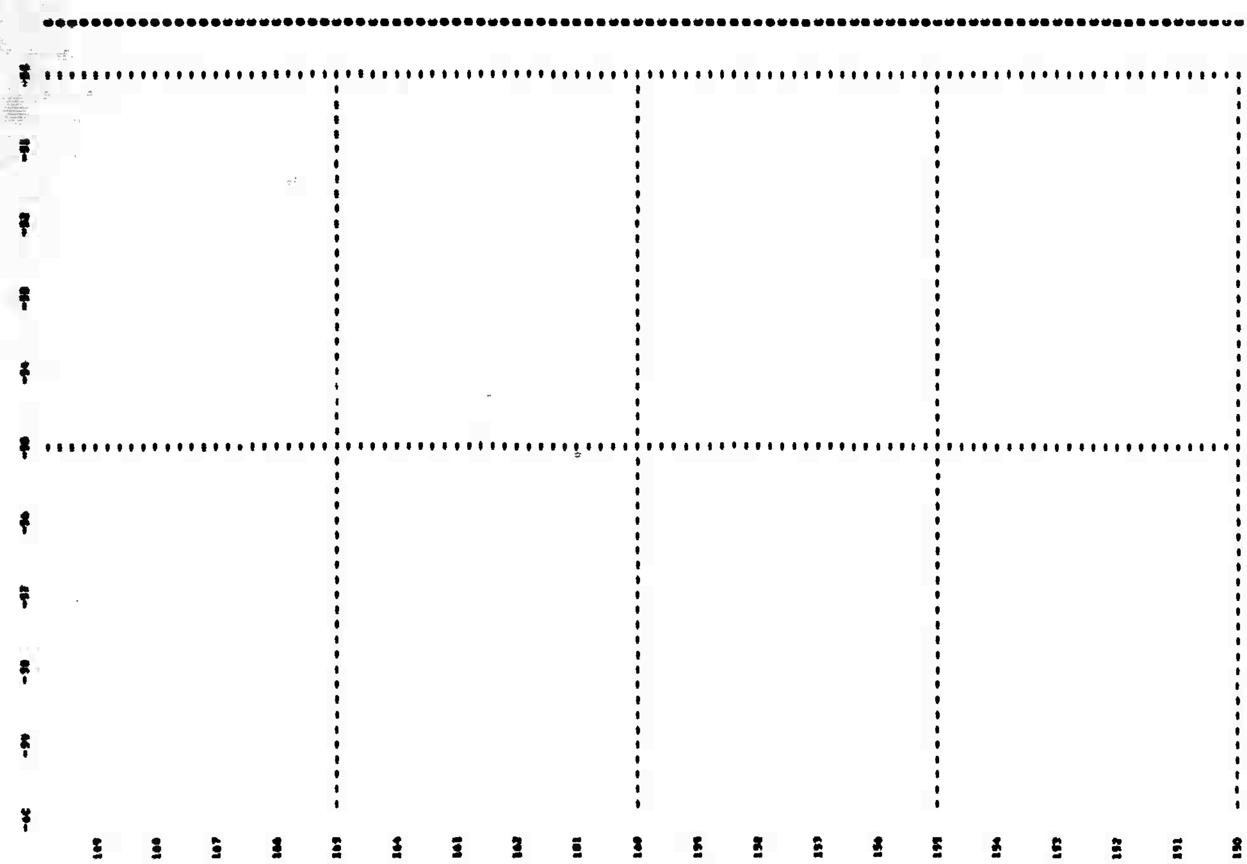


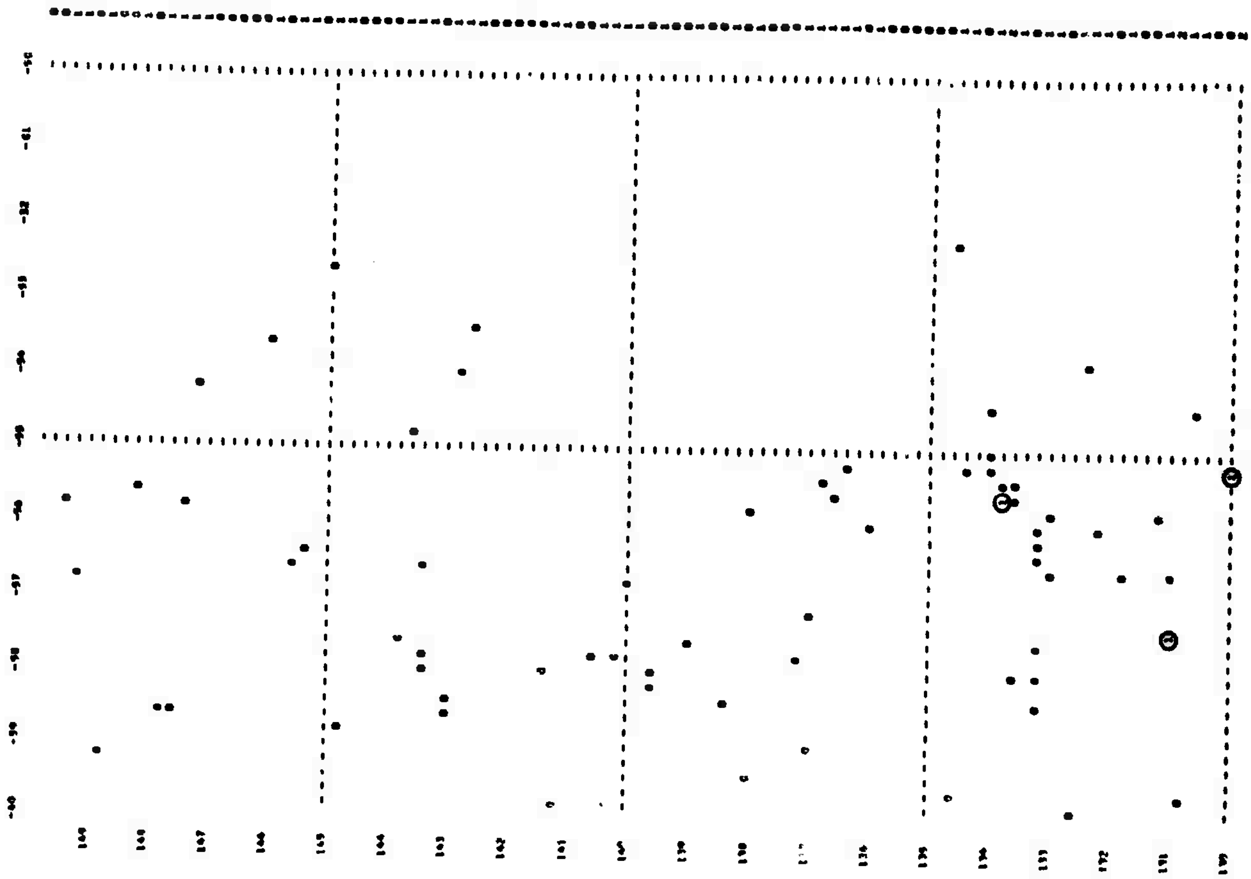


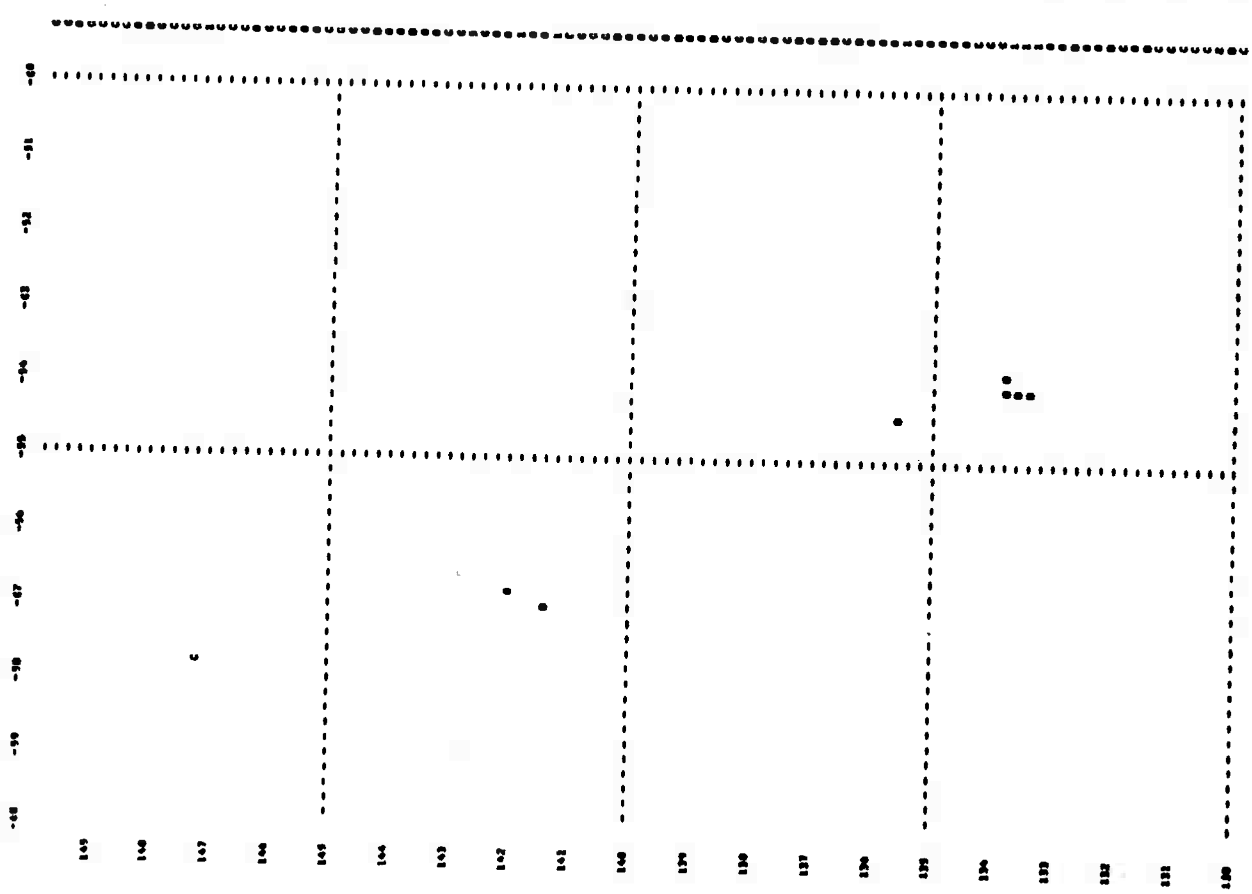


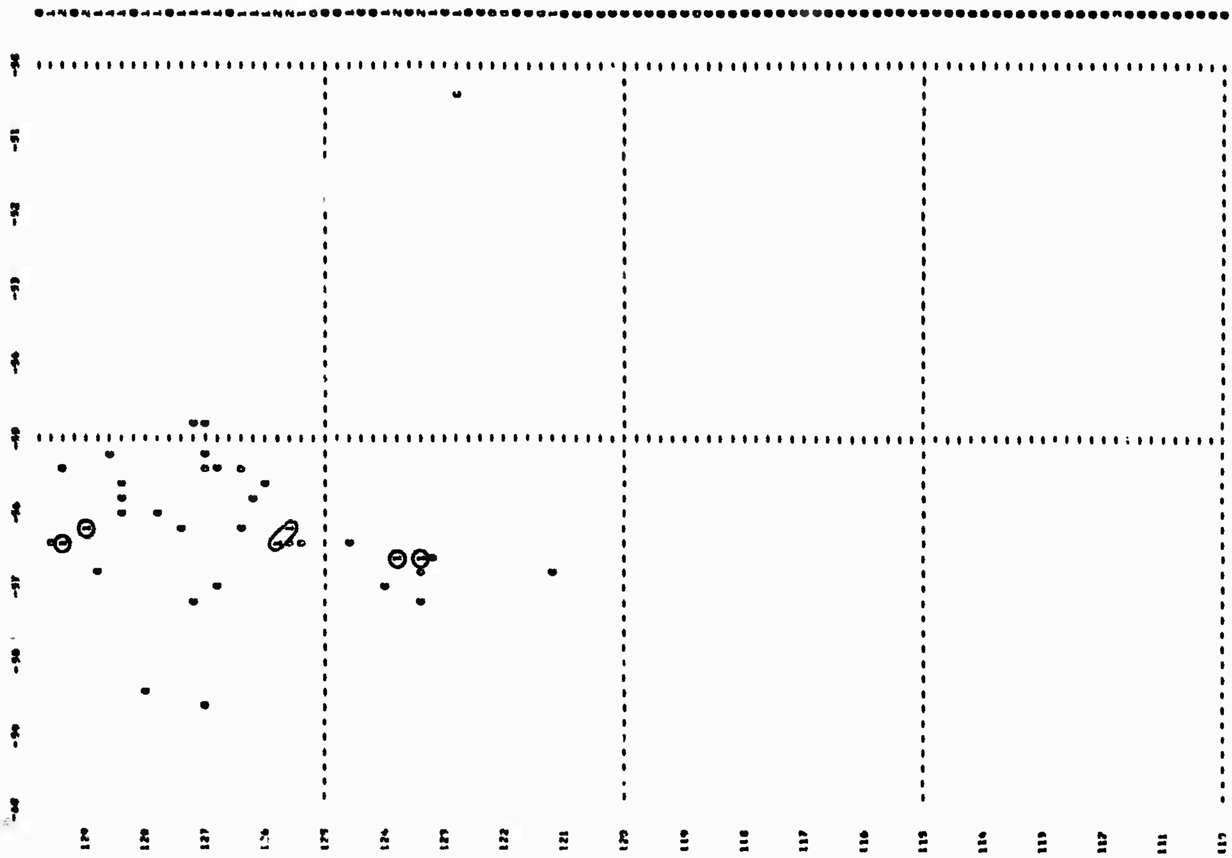


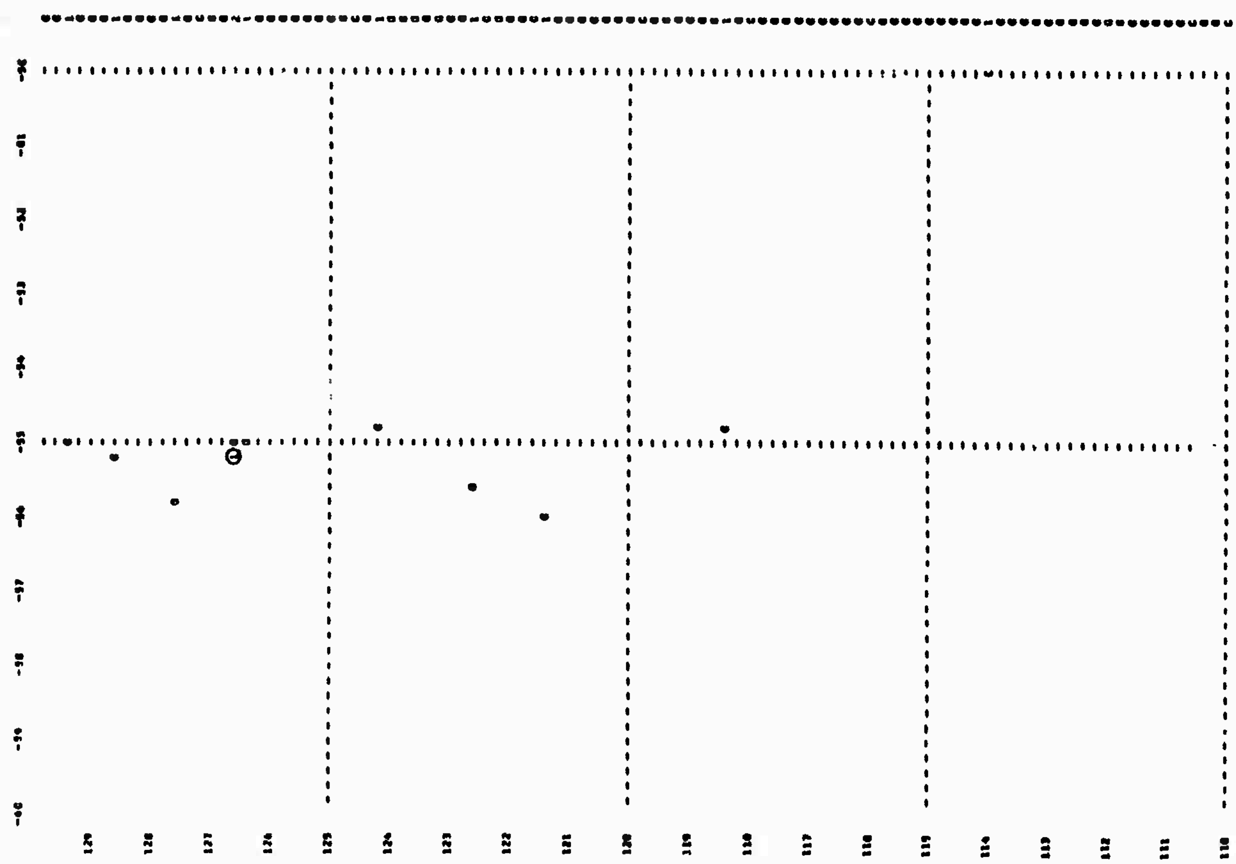


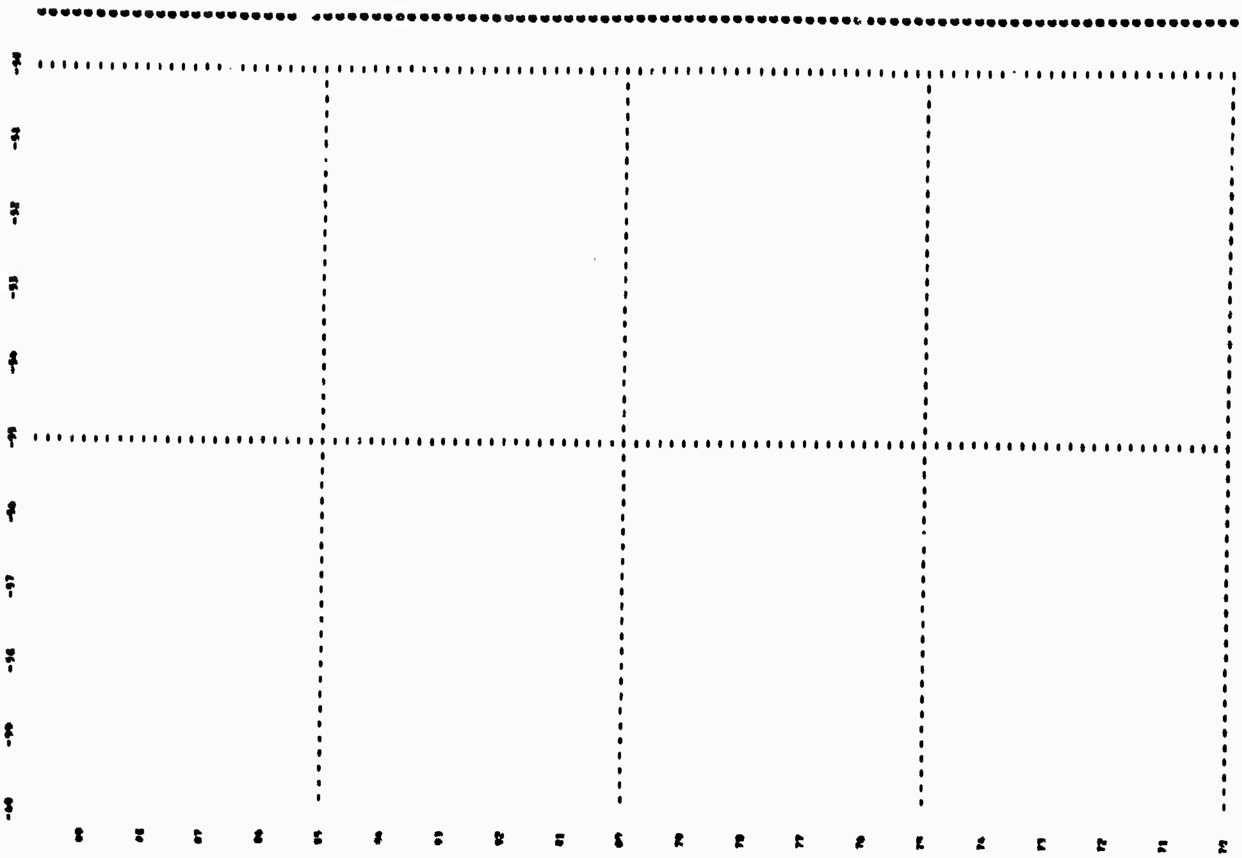


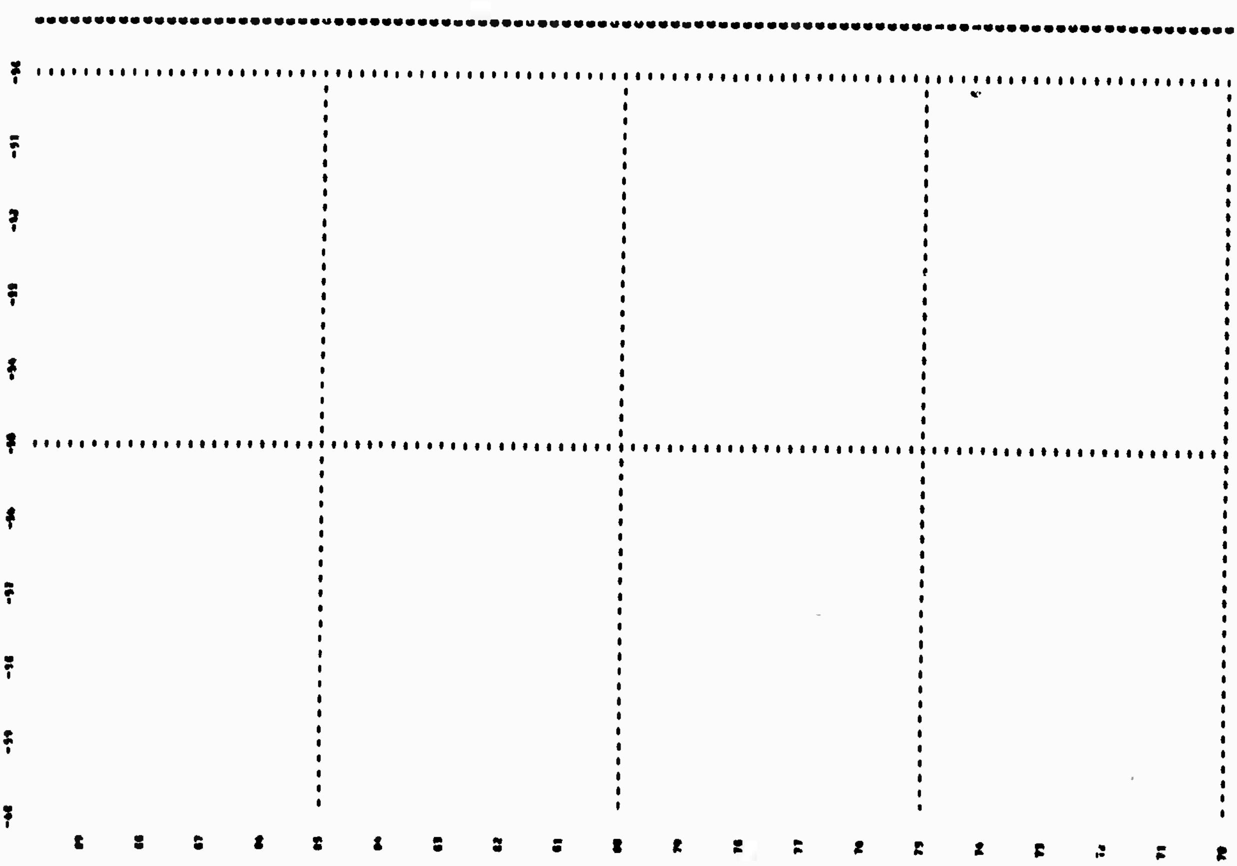


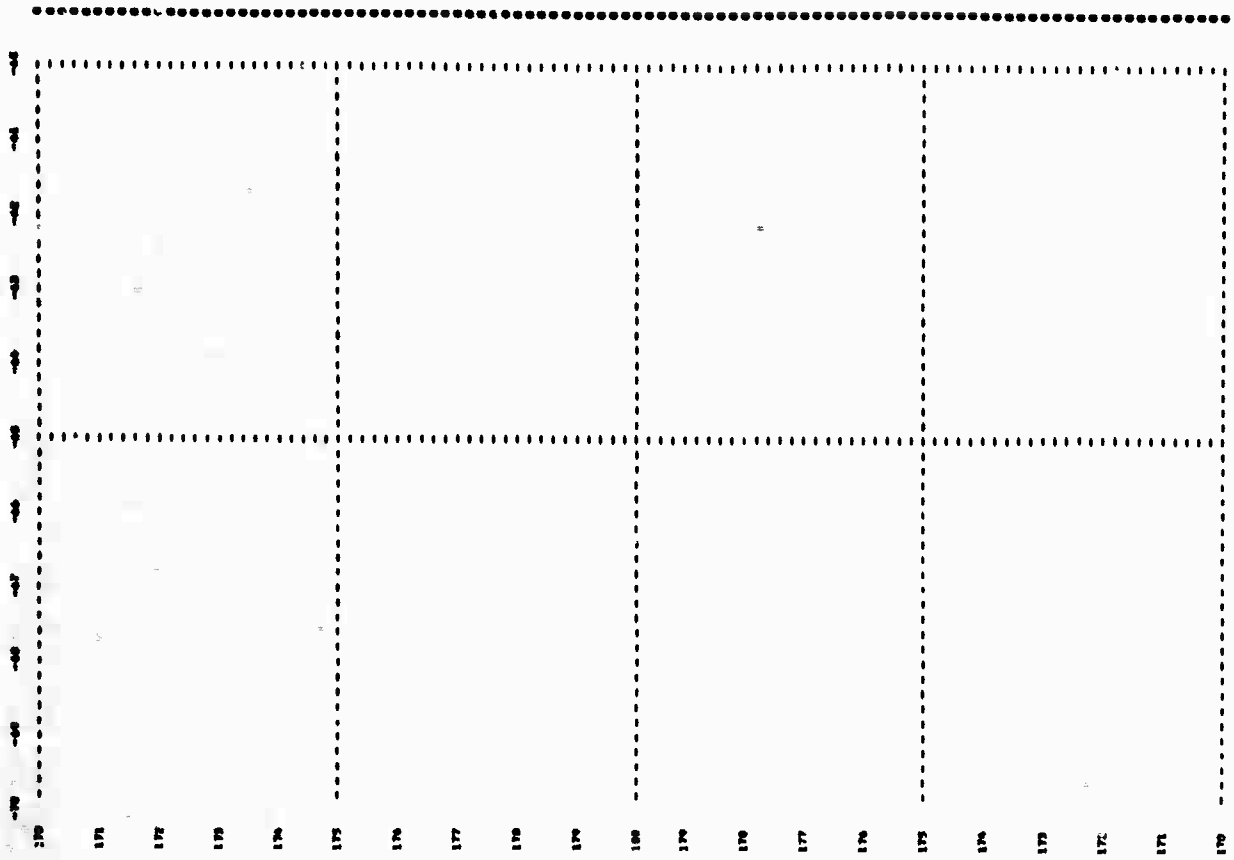


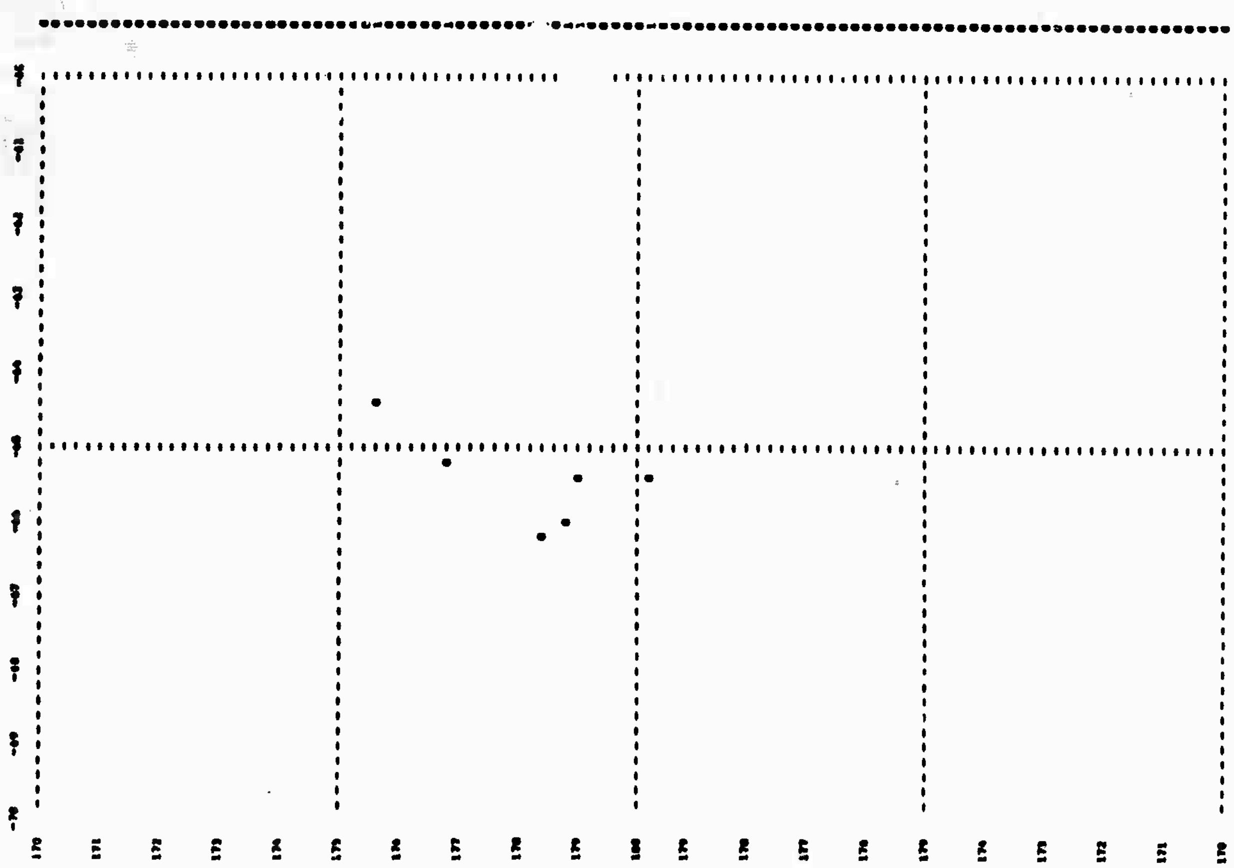


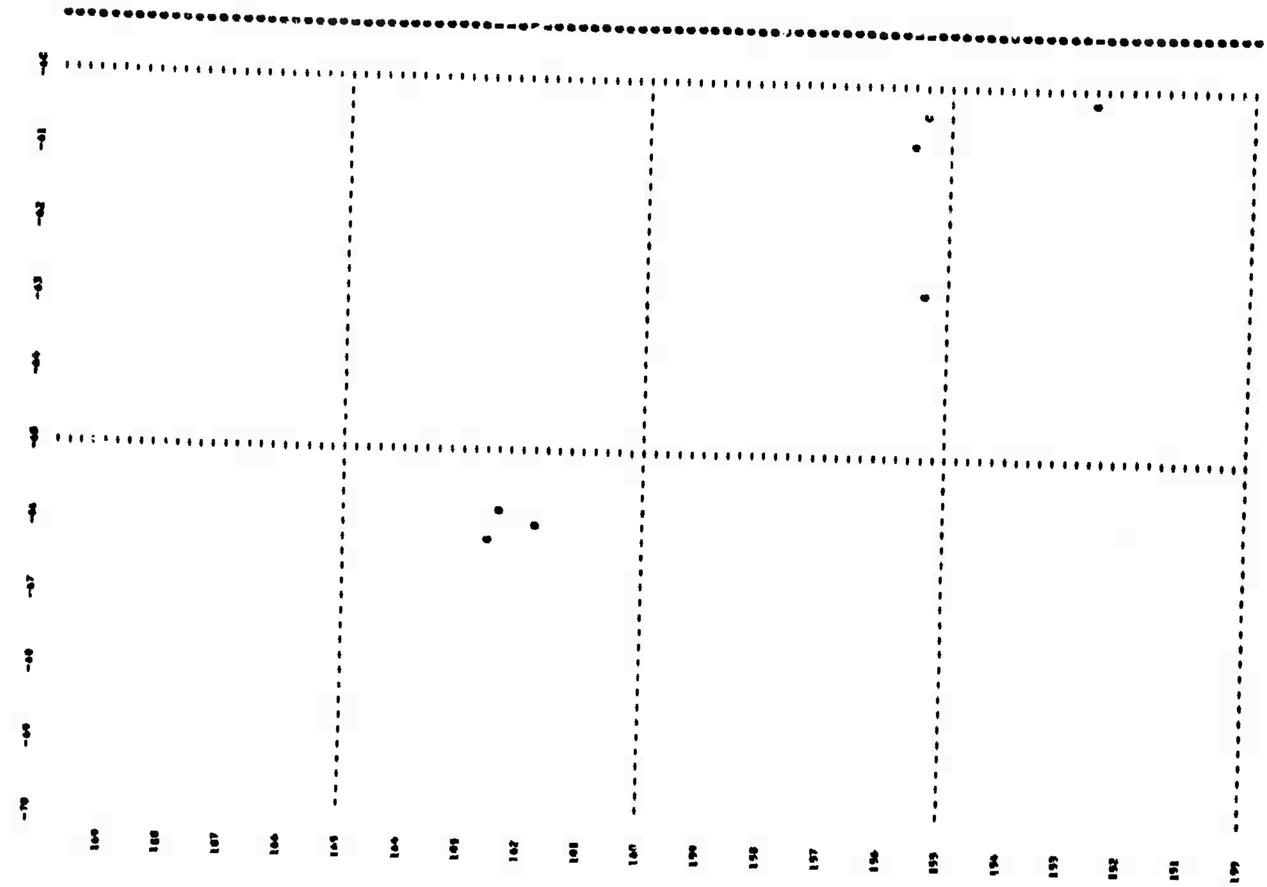


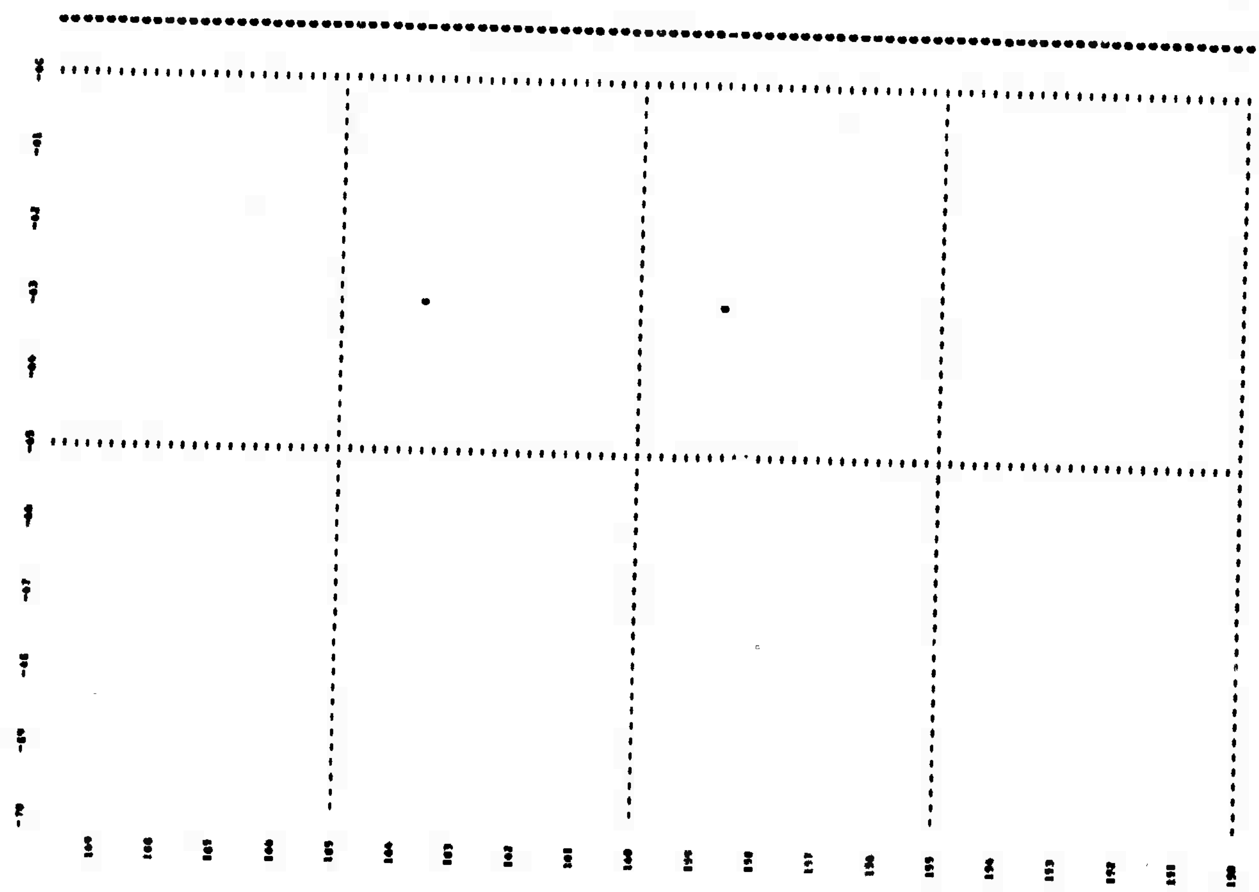


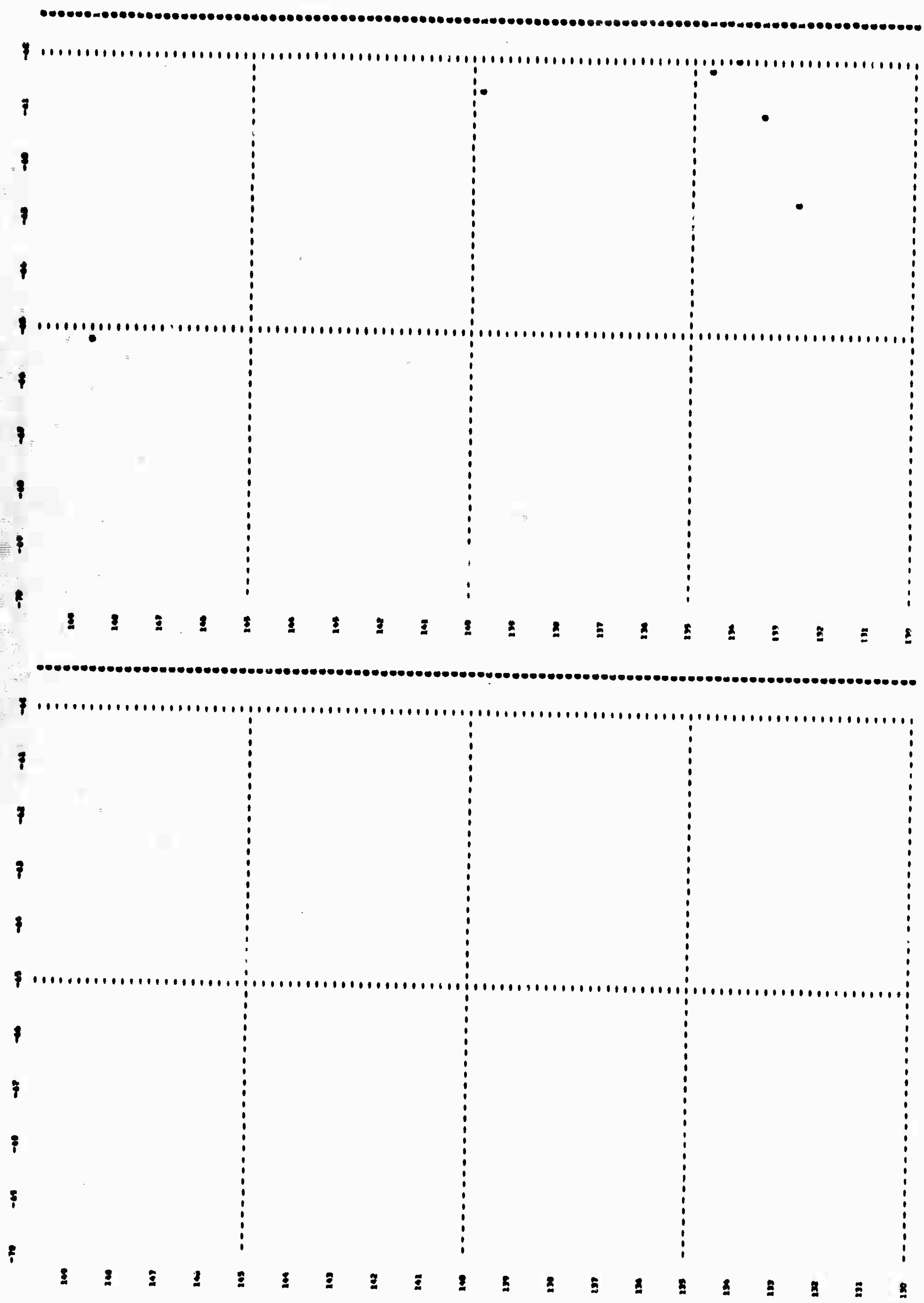


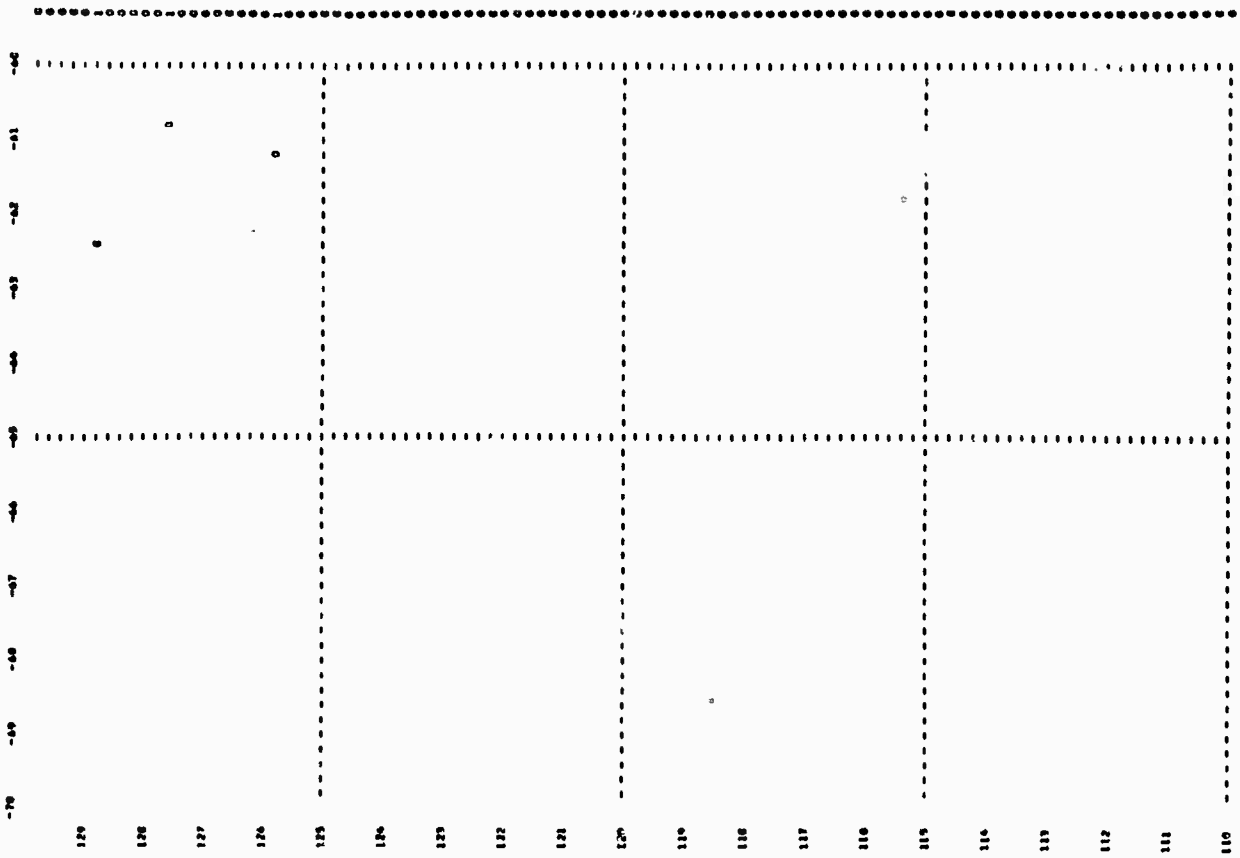


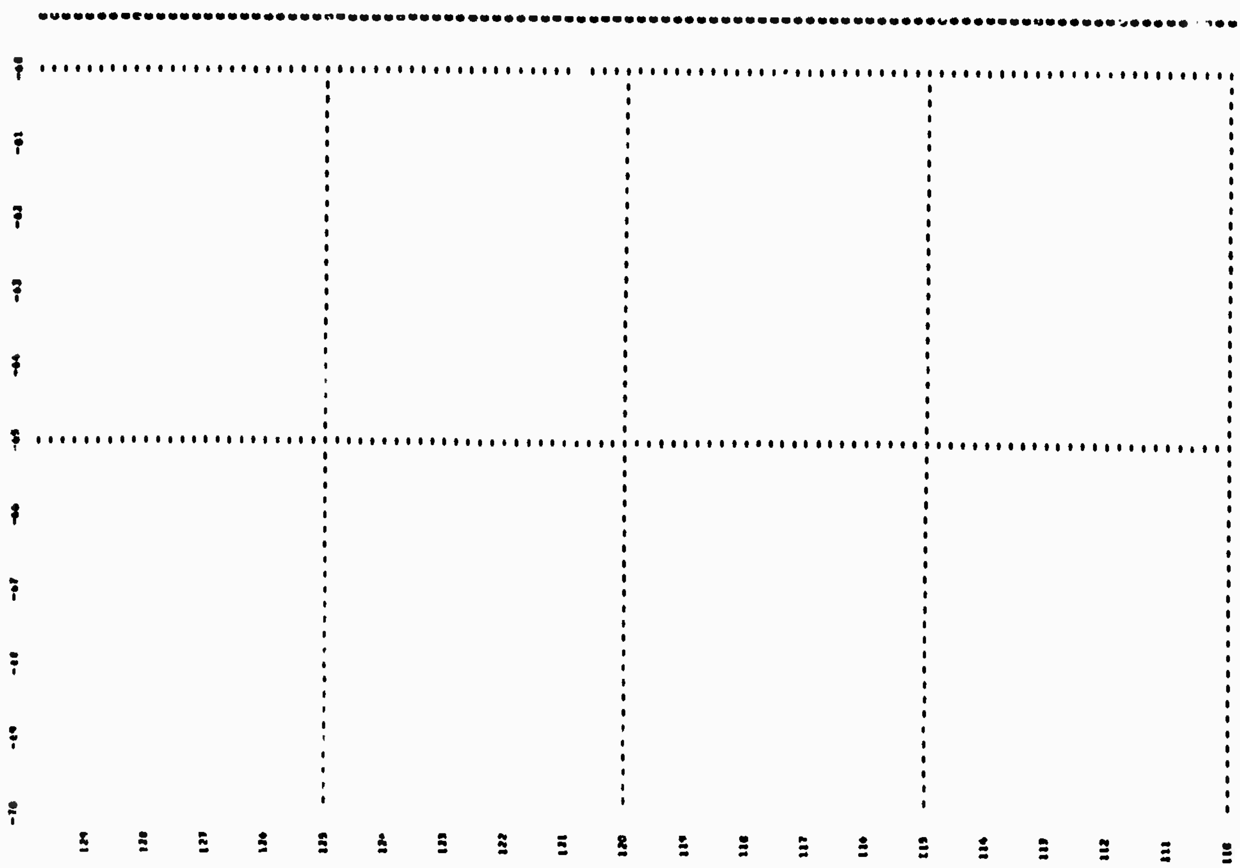












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1. ORIGINATING ACTIVITY (Corporate author) Hawaii Institute of Geophysics University of Hawaii Honolulu, Hawaii 96822	2a. REPORT SECURITY CLASSIFICATION Unclassified 2b. GROUP

3. REPORT TITLE

T-Phase Sources and Earthquake Earthquake Epicenters in the Pacific Basin

4. DESCRIPTIVE NOTES (Type of report and inclusive dates)

Technical Summary Report

5. AUTHOR(S) (Last name, first name, initial)

Duennebier, Frederick K. and Johnson, Rockne H.

6. REPORT DATE	7a. TOTAL NO. OF PAGES	7b. NO. OF REFS
December 1967	100 pp., 6 figs.	8

8a. CONTRACT OR GRANT NO. Contract No. Nonr-3748(01) b. PROJECT NO. c. Project Code 8100 d.	9a. ORIGINATOR'S REPORT NUMBER(S) HIG-67-24 9b. OTHER REPORT NO(S) (Any other numbers that may be assigned this report) none

10. AVAILABILITY/LIMITATION NOTICES

No limitation

11. SUPPLEMENTARY NOTES	12. SPONSORING MILITARY ACTIVITY
None	Advanced Research Projects Agency

13. ABSTRACT

Two years of T-phase source locations are compiled together with U. S. Coast and Geodetic Survey earthquake epicenters in the Pacific Basin for the same time period. It is shown that the T-phase sources have a higher density in regions which insonify the hydrophone array and an accuracy equivalent to or better than C&GS epicenters in regions where geometry is favorable, or where abyssal T phases are generated. ( )

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14 KEY WORDS	LINK A ROLE	LINK A WT	LINK B ROLE	LINK B WT	LINK C ROLE	LINK C WT
T Phase						
Sofar						
Hydrophone						
Epicenter						
Earthquake						
Seismicity						

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